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Predicting a New Student's Mathematics Achievement Based on Prior Student Performance

Iyad Suleiman, Tel Hai Academic College, Israel
Rozan Abbas, The Max Stern Yezreel Valley College, Israel
Amani Attallah, The Max Stern Yezreel Valley College, Israel
Rula Jiryis, Kinneret Academic College, Israel

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Abstract

Mathematics achievement is widely recognized as a critical predictor of academic success and future participation in science, technology, engineering, and mathematics (STEM) fields. However, many educational systems struggle to identify students at risk of underperformance early enough to provide effective intervention. This study proposes a data-driven approach for predicting a new student's mathematics achievement based on historical student performance data. Using a publicly available dataset, two predictive modeling techniques—multiple linear regression and random forest regression (see Breiman, 2001; Kuhn & Johnson, 2013)—are applied to estimate mathematics scores and identify key contributing factors. The modeling pipeline includes data preprocessing, categorical encoding, feature scaling, feature selection, and cross-validation. Model performance is evaluated using mean squared error (MSE) and the coefficient of determination (R^2). Results indicate that multiple linear regression outperforms random forest regression in both predictive accuracy and interpretability, with reading and writing scores emerging as the most influential predictors. The findings highlight the potential of interpretable machine learning models to support educational decision-making and targeted pedagogical interventions (Breiman, 2001; OECD, 2019; Siegler et al., 2012).

Keywords: mathematics achievement, educational data mining, predictive modeling, linear regression, random forest

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Introduction

Student achievement in mathematics has long been a central concern in educational research and policy due to its strong association with academic progression, employability, and long-term socioeconomic outcomes. Despite increased investment in education, substantial performance gaps in mathematics persist across diverse student populations. Traditional assessment methods often identify learning difficulties only after they have become entrenched, limiting the effectiveness of remedial interventions.

Recent advances in educational data mining and machine learning provide new opportunities to analyze large-scale educational datasets and uncover patterns not readily identifiable through conventional statistical approaches. Predictive modeling enables the early identification of students who may require academic support by leveraging historical performance indicators (see Baker & Inventado, 2014; Breiman, 2001; Kuhn & Johnson, 2013; Romero & Ventura, 2020).

The objectives of this study are twofold: (a) to predict the mathematics achievement of a new student based on prior student data and (b) to identify the most influential features contributing to mathematics performance. By comparing a parametric linear model with a nonparametric ensemble model, this research seeks to balance predictive accuracy with interpretability—an essential requirement in educational contexts.

Theoretical Background

Predictive Modeling in Education

Predictive modeling has become an increasingly influential paradigm in educational research, particularly within the broader field of educational data mining (EDM) and learning analytics. These approaches aim to leverage historical educational data to identify patterns, predict academic outcomes, and support data-informed decision-making at both instructional and policy levels. Prior research demonstrates that predictive models can effectively identify students at risk of academic failure, enabling early interventions that are timelier and more targeted than traditional assessment practices (Baker & Inventado, 2014; Romero & Ventura, 2020).

In the context of mathematics education, predictive analytics has been widely applied to examine how prior academic performance, demographic variables, and learning-related factors contribute to future achievement. Large-scale assessments such as PISA consistently reveal strong correlations between mathematics achievement and literacy-related competencies, including reading comprehension and written expression, suggesting shared underlying cognitive processes such as abstraction, symbolic reasoning, and problem representation (OECD, 2019; Siegler et al., 2012). These findings provide a theoretical justification for incorporating reading and writing scores as key predictors in models of mathematics achievement. (OECD, 2019).

Multiple Linear Regression in Educational Research

Multiple linear regression (MLR) remains one of the most widely used statistical techniques in educational research due to its interpretability, statistical rigor, and strong theoretical foundations. MLR models the linear relationship between a dependent variable and multiple

independent variables, allowing researchers to estimate both the direction and magnitude of each predictor's contribution. In educational contexts, this transparency is particularly valuable, as stakeholders such as educators, policymakers, and school administrators often require clear explanations of model behavior rather than purely predictive accuracy (Field, 2018; Gelman et al., 2020).

Despite its advantages, MLR relies on several assumptions, including linearity, independence of errors, homoscedasticity, and absence of multicollinearity. Violations of these assumptions may limit its ability to capture complex or nonlinear relationships inherent in educational data. Nevertheless, numerous studies have shown that linear models often perform competitively with more complex machine learning methods when relationships are approximately linear and when predictors are strongly correlated with the outcome variable (Gelman et al., 2020). This balance between performance and interpretability makes MLR a strong baseline model for educational prediction tasks.

Random Forest Regression and Ensemble Learning

Random forest regression is a nonparametric ensemble learning method that constructs a large number of decision trees using bootstrap sampling and random feature selection, and aggregates their predictions to produce a final estimate (Breiman, 2001). This approach is particularly effective in capturing nonlinear relationships and complex interactions between predictors without requiring explicit model specification. As a result, random forests have been widely adopted in educational data mining for tasks such as performance prediction, dropout detection, and behavioral modeling (Cutler et al., 2012; Kotsiantis et al., 2013).

However, the increased flexibility of random forest models comes at the cost of reduced interpretability. While feature importance measures provide some insight into predictor relevance, these measures may be biased toward variables with higher variability or larger numbers of distinct values (Strobl et al., 2007). In educational settings, where explainability and fairness are critical considerations, such limitations must be carefully weighed against potential gains in predictive accuracy. Consequently, comparing random forest regression with interpretable linear models offers valuable insight into the trade-offs between complexity and transparency.

Feature Selection and Interpretability

Feature selection plays a central role in predictive modeling by identifying the most informative predictors while reducing dimensionality, overfitting, and computational complexity. In educational research, effective feature selection also enhances interpretability, allowing researchers to align model outputs with established theoretical frameworks of learning and achievement. Techniques such as recursive feature elimination (RFE), permutation importance, and model-based importance scores are commonly employed to assess predictor relevance (Guyon & Elisseeff, 2003; Kuhn & Johnson, 2013).

Importantly, feature selection should not be treated as a purely algorithmic process. Domain knowledge and theoretical considerations are essential to ensure that selected features are meaningful, available at prediction time, and ethically appropriate. In this study, feature selection is used not only to improve predictive performance but also to support theoretically grounded interpretations of the factors influencing mathematics achievement.

Method

Dataset

The dataset was obtained from the Kaggle platform and includes 1,000 student records comprising demographic attributes, academic background variables, and standardized test scores. The outcome variable is mathematics achievement. Predictor variables include gender, race/ethnicity, parental level of education, lunch type, test preparation course, reading score, and writing score. A student identification variable was excluded from modeling.

Data Preprocessing

Numerical variables were standardized using z-score normalization. Categorical variables were encoded using label encoding for feature selection and one-hot encoding for regression modeling. Although no missing values were present, mean imputation was applied to numerical features to enhance robustness.

Experimental Design

The dataset was split into training (80%) and testing (20%) sets using a fixed random seed. Two models were trained: multiple linear regression and random forest regression with 200 trees. Model performance was evaluated using mean squared error (MSE) and R^2 . Five-fold cross-validation was conducted to assess generalization stability (Breiman, 2001).

Results

Predictive Performance

Multiple linear regression achieved superior performance ($MSE = 27.33$, $R^2 = .88$) compared with random forest regression ($MSE = 38.94$, $R^2 = .84$), indicating predominantly linear relationships between predictors and mathematics achievement (Breiman, 2001).

Table 1

Predictive Performance of Models on the Test Set

Model	MSE ↓	R^2 ↑
Multiple Linear Regression	27.33	0.88
Random Forest Regression	38.94	0.84

Note. MSE = mean squared error; R^2 = coefficient of determination. Lower MSE values and higher R^2 values indicate better predictive performance.

Cross-Validation

Cross-validation results confirmed the robustness of both models, with linear regression demonstrating lower variance across folds.

Table 2*Five-Fold Cross-Validation Results*

Model	CV MSE (M $\pm$ SD)	CV R ² (M $\pm$ SD)
Multiple Linear Regression	31.32 $\pm$ 3.22	.866 $\pm$.013
Random Forest Regression	40.02 $\pm$ 3.32	.829 $\pm$.016

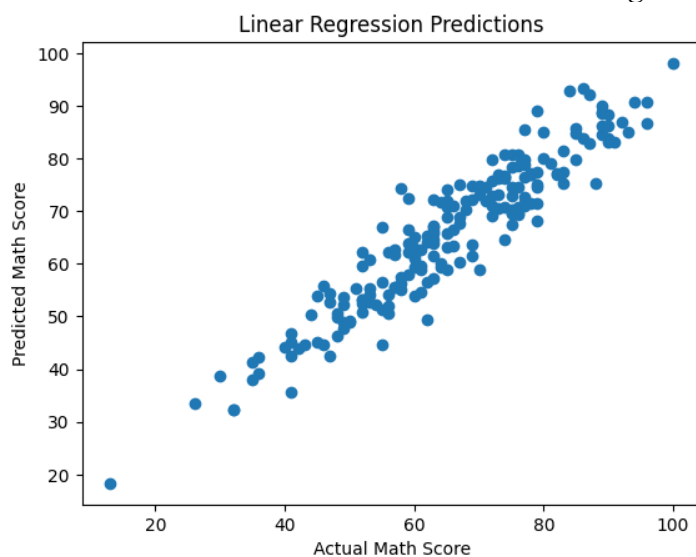
Feature Importance

Recursive feature elimination for linear regression consistently selected reading score, writing score, gender, and test preparation course. Random forest feature importance analysis revealed that reading and writing scores accounted for the majority of predictive contribution.

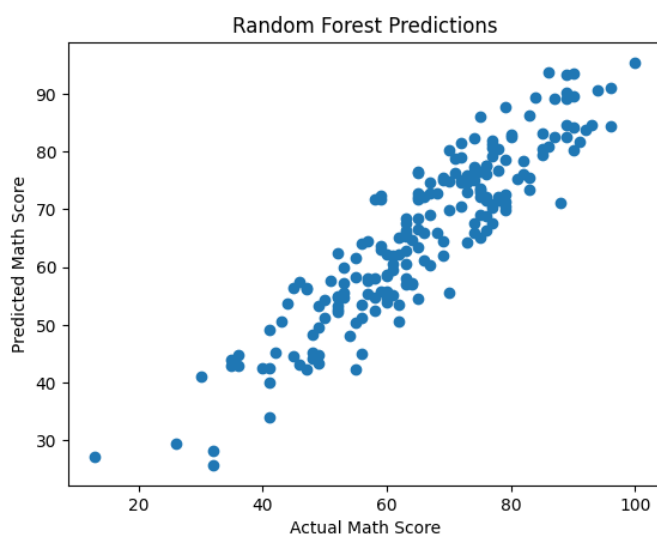
Table 3*Top Feature Importances Identified by Random Forest Regression*

Feature	Importance
Reading score	0.606
Writing score	0.165
Gender (male)	0.119
Student ID	0.039
Test preparation course (none)	0.014
Lunch type (standard)	0.013
Race/ethnicity (Group E)	0.01
Parental education (some college)	0.006
Race/ethnicity (Group C)	0.005
Parental education (some high school)	0.005

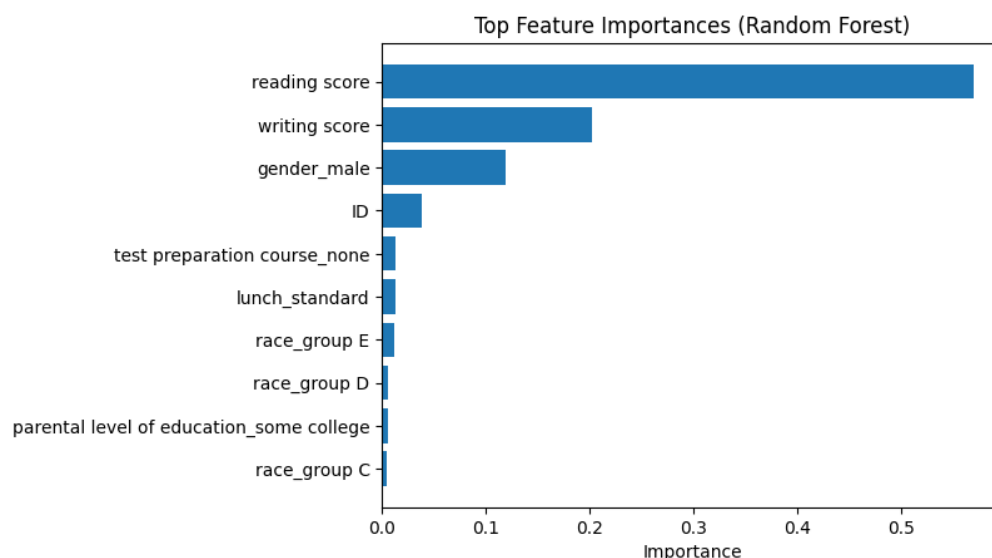
Graphical Interpretation (APA Style)

Figure 1*Observed vs. Predicted Mathematics Scores Using Multiple Linear Regression*

Note. Each point represents a student observation. The diagonal line indicates perfect prediction. The strong alignment along the diagonal reflects high predictive accuracy.

Figure 2*Observed vs. Predicted Mathematics Scores Using Random Forest Regression*

Note. Predictions show greater dispersion compared with linear regression, indicating reduced accuracy and increased variance.

Figure 3*Feature Importance Rankings From the Random Forest Model*

Note. Reading and writing scores contribute the majority of predictive power, highlighting the central role of literacy-related skills in mathematics achievement.

Discussion

The results reinforce existing educational research demonstrating strong associations between literacy-related skills and mathematics achievement. Although random forest regression captured complex patterns, its added complexity did not yield superior predictive performance. The interpretability and stability of linear regression make it more suitable for educational applications where transparency is essential (Breiman, 2001).

Conclusion

This study demonstrates the effectiveness of interpretable machine learning models for predicting mathematics achievement. Multiple linear regression, combined with feature selection and cross-validation, provides a reliable and transparent approach for early identification of students at risk. Future research may incorporate longitudinal data, hybrid nonlinear models, or causal inference techniques.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The authors declare that ChatGPT (OpenAI), a generative AI–assisted language tool, was used during the preparation of this manuscript. The use of the tool was limited to language editing, stylistic refinement, structural reorganization, and assistance with formatting according to conference submission guidelines.

ChatGPT was not used to generate original research ideas, data, analyses, results, or interpretations. All research design, methodological decisions, data analysis, findings, and conclusions are the sole work and responsibility of the authors. The authors reviewed and edited all AI-assisted content to ensure accuracy, academic integrity, and compliance with scholarly standards.

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Advantages and Considerations of e-Portfolios Using General-Purpose Cloud Tools in Elementary School English Education

Aki Ohta, Beppu University Junior College, Japan
Shin Kurata, Nagasaki University, Japan
Emiko Izumi, Kwansei Gakuin University, Japan

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Abstract

This study investigates the advantages and challenges of integrating e-portfolios, built on general-purpose cloud tools, into elementary school English education. E-portfolios are recognized for fostering student-centered and reflective learning, promoting metacognition, peer interaction, and formative assessment. However, their practical implementation in primary education faces constraints such as limited time and varying technical proficiency. To explore real-world applications, we conducted semi-structured interviews with three experienced elementary school teachers who had utilized Google for Education-based e-portfolios for over a year. Qualitative data were analyzed to identify recurring themes regarding both benefits and challenges. The analysis involved the extraction and categorization of advantages and considerations from interview transcripts by the first and second authors, with all authors finalizing the themes and their descriptions. Our analysis revealed five key advantages: (1) enhanced comparative activities (with peers and past work); (2) improved teacher assessment efficiency; (3) increased opportunities for learner autonomy; (4) enriched learning outcomes (e.g., deeper reflections, higher-quality student performance); and (5) greater efficiency in managing learning processes. Conversely, four main considerations emerged: (1) varying digital literacy levels among students and teachers; (2) limited class time for e-portfolio use; (3) the need to clearly communicate e-portfolio benefits to students; and (4) constraints in providing individualized feedback. These findings suggest that while e-portfolios offer significant educational value, successful integration necessitates institutional support, technical training, and thoughtful instructional design. This study contributes to the understanding of effective digital portfolio use in elementary foreign language education and provides practical insights for future implementation.

Keywords: e-portfolio, elementary school English education, general-purpose cloud tools, ICT in education, self-regulated learning

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Introduction

Elementary School Foreign Language Education and “Attitude Toward Learning”

In school education, importance is placed on three pillars: “Knowledge and Skills,” “Thinking, Judgment, and Expression,” and “Attitude Toward Learning/Humanity.” In particular, “Attitude Toward Learning/Humanity” is positioned as an element that nurtures the attitude of children to learn proactively while interacting with society and the world, requiring respect for diversity and collaborative skills.

In Elementary School Foreign Language Education, the goal is to cultivate active communication skills accompanied by cross-cultural understanding and consideration for others. Furthermore, language acquisition requires continuous effort, and fostering autonomy as a learner is emphasized (MEXT, 2017a). In foreign language learning, experiences of thinking, judging, and expressing while utilizing knowledge and skills are important. Learning is consolidated by choosing appropriate words and repeating expressions through actual communication. In this process, the three pillars interact, and “Attitude Toward Learning/Humanity” is cultivated. The Course of Study emphasizes this element to indicate the importance of fostering an attitude where children learn proactively.

Furthermore, elementary foreign language education serves as the foundation for junior high, high school, and lifelong learning. It requires children to set their own learning goals and cultivate an attitude of continuing to learn autonomously, with teacher support playing a crucial role. Nurturing the ability to reflect on and sustain one's own learning leads to the formation of qualities and abilities required in various social situations in the future (MEXT, 2017b).

As an environment supporting such learning, the “one device per student” initiative and high-speed communication environments have been established in Japanese schools, and learning utilizing various digital tools is spreading rapidly. Sharing examples of digital tool utilization is expected to contribute to the customization of education, reduction of educational disparities, improvement of learning effects, and the promotion of sustainable educational reform. Therefore, the accumulation and analysis of practical cases are indispensable for effective operation.

Learning Utilizing e-Portfolios

One digital tool that supports learning is the portfolio. While there are similar terms such as digital portfolio, electronic portfolio, or web portfolio, this paper refers to portfolios handling digital data collectively as “e-Portfolios.” According to Morimoto and Inagaki (2017), the role of a portfolio can be broadly divided into two: “the role as evidence substantiating learning outcomes” and “the role as a tool to promote proactive, interactive, and deep learning.”

e-Portfolios allow for recording and managing learning processes, outcomes, and reflections in digital format, in addition to showing learning outcomes based on evidence. They are important educational tools for fostering self-regulation skills, enabling learners to systematically collect, organize, and reflect on their learning activities. With the GIGA School Program providing devices and networks, the possibility of introducing portfolios that promote proactive, interactive, and deep learning has increased (MEXT, 2022).

Data handled in portfolios can be divided into “Learning History” and “Learning Records” (Morimoto, 2015). Learning history refers to educational data automatically recorded by systems, such as learning logs and operation logs. Learning records are educational data created by the learners themselves, such as tests, artifacts, and reflections. e-Portfolios can visualize learning progress based on this data and provide concrete evidence for self-regulation. In this way, e-Portfolios promote learner self-regulation and support continuous learning and growth. Furthermore, portfolios function as a platform to strengthen communication between teachers and learners and provide individual feedback. This allows learners to gain a deeper understanding of their learning process and effectively adjust their individual learning paths. Thus, portfolios play an important role in fostering self-regulation skills and providing a foundation for learners to acquire 21st-century skills and grow as lifelong learners.

On the other hand, merely introducing e-Portfolios does not ensure that learners will learn proactively (Morimoto, 2015). The role of the teacher is crucial when using accumulated learning outcomes for learning (Matsuo, 2021). To develop proactive, interactive, and deep learning using e-Portfolios, continuous lesson improvement and learning support by teachers are necessary. This is particularly true in elementary schools, where many learners have not yet established their learning methods.

Portfolios Using General-Purpose Cloud Tools in Elementary English Education

The use of cloud tools has attracted attention in educational settings as a method for learning reflection and evaluation. While traditional paper-based reflection sheets had some effectiveness, issues such as complicated management and increased teacher burden were pointed out (Imanishi, 2023). There were also limits to sharing learning processes and promoting mutual evaluation with paper media. To resolve these issues, attempts have been made to introduce general-purpose cloud tools to rethink methods of recording, sharing, and reflecting on learning.

Ota et al. (2024) reported on the practice of Elementary School Foreign Language utilizing portfolios based on general-purpose cloud tools (specifically Google Forms and Google Sheets). The use of cloud tools streamlined the management of individual learning records, enabled rapid teacher feedback, and created opportunities for mutual evaluation through the sharing of outcomes among learners. Furthermore, the centralization of learning history built an environment where children could reflect on their learning and connect it to continuous learning. Attempts were also made to visualize learning processes and thought flows to support learner agency. Such practices aimed not just at a transition from paper to digital, but at the qualitative improvement of the learning process.

This study explores the nature of learning support in educational settings through the practice of reflection using cloud tools. While Ota et al. (2024) identified some results and issues, the advantages and considerations of e-portfolios using general-purpose cloud tools in elementary English education have not been organized. Organizing these points would be beneficial for teachers intending to use such tools and significant for fostering children's attitude toward learning.

Aim of This Paper

The aim of this paper is to present the advantages and considerations of portfolios using general-purpose cloud tools in elementary school English education. To this end, we interviewed teachers who have used such e-portfolios, investigating and organizing the points regarding advantages and considerations. Specifically, to organize the characteristics of lessons that realize self-regulated learning, we conducted semi-structured interviews with teachers who have used portfolios developed using Google for Education services for more than one year. The interviews focused on continuous lesson improvement and learning support, asking about successes and difficulties in teacher support.

Survey and Analysis

To achieve the aim of this study, semi-structured interviews were conducted with teachers possessing the relevant practical experience. The interviews took place in January 2025, lasting about 30 minutes each, including explanations. The interviews were conducted individually online via video conferencing tools. Focusing on continuous lesson improvement and learning support, the main question asked was, “In practicing portfolios using general-purpose cloud tools in elementary foreign language activities, how did you improve lessons or support children?” This served as a prompt to elicit successes and difficulties.

The subjects were three teachers (Teacher A, Teacher B, Teacher C):

- Teacher A: 21 years of elementary school experience, 11 years of foreign language teaching experience.
- Teacher B: 26 years of elementary school experience, 17 years of foreign language teaching experience (including periods as a research designate).
- Teacher C: 14 years of elementary school experience, 11 years of foreign language teaching experience.

All three have experience as research heads promoting foreign language education within their schools, have served as committee members or managers promoting foreign language education for their municipalities, and have used portfolios developed with Google for Education services for more than one year. A rapport had been established between the primary author and the teachers.

The analysis method involved summarizing the responses from the verbatim records regarding the two main questions, extracting parts related to advantages and considerations, and then organizing and listing them. Extraction and listing were performed jointly by the first and second authors, with disagreements resolved through consultation. The final decision on checklist items and wording was made after consultation among all authors.

Advantages of Learning Using e-Portfolios

The advantages of learning using e-Portfolios are shown in Table 1. As a result of the interview survey, advantages were organized into five major categories: [Advancement of Comparative Activities], [Efficiency of Evaluation], [Increased Self-Determination Opportunities], [Learning Effects], and [Efficiency of Learning]. These were further divided into sub-categories.

Table 1*Advantages of Learning Using e-Portfolios*

Major Category	Sub-Category	Summary of Advantage
Advancement of Comparative Activities	Effectiveness regarding reference to others	Information on all students' learning can be shared and referenced in real-time.
	Effectiveness regarding media	Enables comparison not only of text but also of video and audio information.
Efficiency of Evaluation	Time Reduction	Teacher's evaluation time is streamlined by automatically centralizing student learning outcomes.
	Evaluation Support	Enables grasping overall trends of student outcomes and evaluating while confirming the learning process during class.
Increased Self-Determination Opportunities		Increases learning situations where learners can choose their learning methods by their own will.
Learning Effects	Improvement in quality of reflection	Leads to learning effects such as improvement and transformation in the quality of learning.
	Improvement in quality of performance	Children reflect directly on their own performance, and expressiveness in reflection increases. Children try to perform their best due to the situation of being seen by many others.
Efficiency of Learning		Enables efficient execution of learning that was previously difficult to realize.

Advancement of Comparative Activities

This refers to the ability to compare with the past or with others, which was previously impossible.

- Effectiveness regarding reference to others: Teacher A noted that because files are shared instantly, teachers can easily ask specific students to share, and children can see others' thoughts and type while referencing them. Teacher B mentioned that folder sharing made it easier to view friends' reflections and observe each other. Teacher C noted that real-time sharing of spreadsheets stimulates children. This suggests that e-portfolios promote comparative activities through immediacy and ease of referencing others. In elementary English, where performance evaluation is frequent, this is particularly effective for video-based formative evaluation.
- Effectiveness regarding media: Teacher B stated that while paper has the advantage of accumulation, comparing past and present units is difficult. Digital formats allow for side-by-side comparison of images or videos, enabling immediate self-comparison. Teacher B also noted that for middle-grade students, direct comparison of performance videos fits better than text. This visual comparison is a significant advantage in English education, where gestures and eye contact are important.

Efficiency of Evaluation

This refers to increased efficiency in teachers' evaluation activities.

1. Time Reduction: Teacher A reported that digitizing self-evaluation sheets significantly reduced the time required for organizing data and reflecting on the lesson/student understanding compared to paper methods.
2. Evaluation Support: Teacher A mentioned that as familiarity grew, they could focus more on the content. Teacher B noted that digital aggregation makes it easier to see trends in student thoughts compared to paper. Teacher C emphasized the ability to view reflection sheets in real-time during class and provide immediate feedback or share them on a TV screen. This indicates that efficiency leads to higher quality analysis and real-time feedback.

Increased Self-Determination Opportunities

This refers to increasing situations where learners choose their learning methods. Teacher A described a shift from teacher-led progression to setting broad goals with students and allowing them to choose their approach/method to reach that goal (like choosing a path up a mountain). Teacher C noted a change from passively watching a representative student to allowing children to freely choose which friend's performance they wanted to watch. This suggests that increasing self-determination enhances flexibility and fosters the ability to think and act independently.

Learning Effects

This refers to improvements in the quality of learning.

- Improvement in quality of reflection: Teacher B noted that recording videos for each unit allows children to reflect on their speech and gestures, leading to improvements. Teacher C observed that giving ample time to watch friends' work led to more concrete reflections and the acquisition of new expressions. This confirms that reviewing past videos is effective for checking the growth of speaking skills.
- Improvement in quality of performance: Teacher C pointed out that the situation where their performance is viewed by others motivates students to "do it properly," raising their consciousness. This environment contributes to higher quality performance.

Efficiency of Learning

Teacher A noted that the "one device per student" environment coincided with the ease of digital reflection and objective self-viewing through video. Teacher C stated that cloud tools made reflection much easier for children compared to analog methods. This suggests e-portfolios facilitate reflection and metacognition.

Considerations for Learning Using e-Portfolios

The considerations (points to note) are shown in Table 2, organized into four categories: [Difficulty], [Class Time], [Clarification of Benefits], and [Limited Feedback].

Table 2*Considerations for Learning Using e-Portfolios*

Major Category	Sub-Category	Summary of Consideration
Difficulty	Student technical skills	Consider students' lack of operation skills during the introduction period.
	Developmental stage	Adjust the content and amount of information for middle vs. high grades.
	Teacher technical skills	Consider the lack of operation skills of teachers developing/operating the e-portfolio.
Class Time		Need to secure sufficient class time.
Clarification of Benefits		First, share the significance of using e-portfolios with learners.
Limited Feedback		Methods for feedback comments on artifacts are limited.

Difficulty

- **Student Technical Skills:** Teacher A noted a dilemma initially as students took time to get used to the system, though efficiency improved over a year. Teacher B highlighted that not all children are technically skilled, requiring time for operation and learning logs. Teacher C mentioned taking ample time for operation initially, prioritizing it over content until students adjusted. This implies the need to simultaneously cultivate information utilization skills.
- **Developmental Stage:** Teacher B pointed out that for middle-grade students, spreadsheets can be visually overwhelming compared to high-grade students. Consequently, they adjusted the method to simple video reflections. This indicates the necessity of adapting tools to the developmental stage.
- **Teacher Technical Skills:** Teacher A noted that colleagues found the initial setup and viewing methods difficult, which hindered adoption. This suggests the importance of support for teachers regarding initial setup and basic operations.

Class Time

Teacher A mentioned that while digital reflection was easy, finding time for student-to-student sharing was a challenge. Teacher B noted that with short units (approx. 4 hours) in middle grades, prioritizing language activities meant utilizing portfolios for comparison in subsequent units rather than immediate interaction. Securing time within a 45-minute lesson is a major struggle. This highlights that while valuable, time management for sharing and advanced use is a critical issue.

Clarification of Benefits

Teacher B emphasized technical support to prevent loss of motivation due to tasks feeling “troublesome” or “difficult.” It is crucial to make students realize the significance (e.g., visualizing growth) and convenience of the tool. Explicitly conveying the benefits is essential for engagement.

Limited Feedback

Teacher A expressed difficulty in providing feedback to everyone. Unlike handwritten notes where teachers can easily write “Good job” or underline specifics, digital feedback feels restrictive regarding where and how to write comments and responding to everyone is burdensome. This indicates a need for efficient and effective digital feedback methods.

Conclusion

This study aimed to present the advantages and considerations of e-portfolios using general-purpose cloud tools in elementary English education. Through interviews with experienced teachers, advantages were categorized into [Advancement of Comparative Activities], [Efficiency of Evaluation], [Increased Self-Determination Opportunities], [Learning Effects], and [Efficiency of Learning]. Considerations were categorized into [Difficulty], [Class Time], [Clarification of Benefits], and [Limited Feedback]. Notably, regarding advantages, recording student performance as video was suggested to be particularly effective for elementary English portfolios. Future research will investigate how teachers utilize these points to advance lesson improvement.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that Gemini was used to proofread and improve the language of this manuscript (e.g., grammar, spelling, and clarity). The author further declares that Gemini was not used to generate any substantive content for this manuscript. The ideas, research design, procedures, results, analyses, and discussion are the author’s own and are based on the careful and systematic conduct of the research.

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Contact email: ohtaaki@nm.beppu-u.ac.jp

Designing a Custom GPT: Considering the Implications for Media Education

John V. Pavlik, Rutgers, The State University of New Jersey, United States
Tristan M. Pavlik, Rutgers, The State University of New Jersey, United States

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Abstract

Custom GPTs present an opportunity for educational innovation. Combining an exploratory and descriptive approach in this emerging arena, we used a case study method to test the potential of a custom GPT in media education. We conducted a qualitative document analysis to assess the textual content generated by a custom GPT and identify themes. To design the custom GPT, we used Open AI's GPT-5, released August 7, 2025. Using agentic artificial intelligence (AI) mode, we generated a custom GPT on media ethics. The resulting custom GPT, Media Ethics Instructor (MEI), features an interface designed for college students using a blend of academic and conversational interaction. Our analysis of the content generated by MEI indicates three themes. First, MEI enables Q&A sessions to help students explore key concepts. In responding to questions about core ethical principles, MEI articulated several media ethics concepts, including seeking truth, minimizing harm, and maintaining human oversight when using generative AI. Second, MEI enables simulations with tailored feedback. A simulated student query was posed regarding the use of anonymous sources in journalism. MEI generated a response highlighting the role of unnamed sources in journalism, especially when protecting source confidentiality. Third, MEI distills trends from historical data. MEI revealed that since media reporting of the 1972 Watergate break-in, media usage of anonymous sources has declined steadily. MEI provided its source materials. Limitations of this study include using a single platform (GPT-5) and only one subject (media ethics), and having no assessment of student learning via a custom GPT.

Keywords: agentic AI, media ethics, education, GPT, anonymous sources

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Introduction

Artificial intelligence (AI) presents both threats to and opportunity for educational innovation. One arena in which AI gives educators possible ways to innovate is the design and creation of custom GPTs. Custom GPTs present possible new ways to engage students. Custom GPTs also present the ability to design personalized learning. Custom GPTs are also adaptable to online learning platforms as well as in in-person teaching and learning settings.

A custom GPT is defined as a specialized generative pretrained transformer (GPT) designed for a specific function, application, or topical domain, often utilized for a specific organization or institution. Custom GPTs have been developed for use in a variety of fields, from the military, such as NIPRGPT (Shaw, 2024) to business, such as Marketer GPT Pro. Image generators are among the most popular custom GPTs. OpenAI's DALL-E is a leading example (Dierolf et al., 2025).

Custom GPTs offer educators several benefits for the application of AI to teaching and learning. First, custom GPTs can be designed with no coding skill required by the educator. Agentic AI mode can conduct the coding at the behest of the human educator. Custom GPTs are a low-cost development option, requiring about \$20 a month subscription to the AI platform. Open-source large language models (LLMs) also present the benefit of transparency, both in terms of design and training materials used in the development of the LLM. Custom GPTs also rely on vetted knowledge bases to minimize potential for errors committed by AI. Custom GPTs are also domain-specific, providing reliable depth of knowledge.

Literature Review

The research literature provides a useful window into the advent of custom GPTs and their potential role in higher education. There is growing experimentation with custom GPTs in higher education. Educators are drawn to the potential utility of custom GPTs to deliver more efficient, reliable, and accurate AI in teaching and learning.

Universities are creating custom GPTs for a variety of reasons, including personalized instruction. Among the universities that have designed such custom GPTs are Harvard (Govindarajan & Sriram, 2023), Duke (Duke Office of Information Technology, 2025), and Michigan (Michigan 2025). Michigan, in fact, has developed multiple custom GPTs, including Go Blue, which is a mobile assistant for UM students, faculty and staff, U-M GPT, which gives access to GPT 4o and more, as well as U-M Maizey, for a personalized GPT experience that can be kept private. MIT Sloan has developed custom GPTs for management instruction. Kabir et al. (2025) have designed and tested a custom GPT for scientific writing, finding that custom GPTs offer several avenues for educational innovation, including interactive instruction in the foundational concepts in management. For our purposes, we chose the general arena of media education to examine the potential utility of a custom GPT.

Methodology: A Case Study Approach

This study relies on a qualitative case study method. In particular, we use an exploratory technique that can enable us to identify possibilities, such as hypotheses, and limitations of custom GPTs. We also use a descriptive technique (Ahmed et al., 2025). This is employed in the arena of document analysis to systematically review the materials generated by the custom GPT and identify themes and categories of the content generated.

OpenAI released GPT-5 on 7 August 2025. In using GPT-5, we were required to purchase a subscription to ChatGPT Plus at \$20 a month. To create the custom GPT, the option we utilized was to employ agentic AI mode to generate a custom GPT for the specific topical domain of media ethics. In this mode, a few short text prompts were sufficient instruction for the agentic AI mode to execute the task of creating a custom GPT. The first prompt was: design custom GPT. ChatGPT responded:

To design a custom GPT effectively, I need some additional details. Could you let me know the intended purpose or domain for the model (e.g., customer support, legal advice, creative writing), any specific guidelines or rules you want it to follow, and the sort of tasks or requests it should handle? This will help me tailor the design to your needs.

Our next prompt: for teaching students about journalism and media. ChatGPT worked for six seconds, and then stated:

Great! To create a custom GPT for teaching students about journalism and media, please let me know a few more specifics so I can tailor it effectively:

1. Student level or age group (e.g., high school, college, or other).
2. Key topics to focus on within journalism and media (e.g., media ethics, news writing, investigative reporting, social media in journalism, etc.).
3. Any particular tone you prefer—formal academic, conversational, or somewhere in between?
4. Any topics or angles to avoid?

Feel free to provide as much or as little detail as you'd like; the more specifics you give, the better I can design the custom GPT for your needs.

We then responded: 1. college level, 2. media ethics, 3. somewhere in between, 4. no topics to avoid. This yielded a Custom GPT titled Media Ethics Instructor (MEI). MEI was designed for college students. The interface is designed as a blend of academic and conversational interaction, with a balanced, engaging manner. MEI blends an academic tone with conversational clarity and is anchored in established ethical frameworks. Further refinement of MEI is possible, but for our purposes, no additional refinements were made.

Figures 1, 2 and 3 are screen shots illustrating the initial prompts we entered and the responses GPT-5 generated. A link to MEI is provided in the references (ChatGPT, 7 August 2025). Users with a ChatGPT account may access this to examine MEI.

Figure 1*Initial Prompt Submitted to GPT-5*

ChatGPT

[Share](#)

design custom gpt



To design a custom GPT effectively, I need some additional details. Could you let me know the intended purpose or domain for the model (e.g., customer support, legal advice, creative writing), any specific guidelines or rules you want it to follow, and the sort of tasks or requests it should handle? This will help me tailor the design to your needs.



Continue

for teaching students about journalism and media

Figure 2*Second Prompt to GPT-5*

ChatGPT

[Share](#)**Custom GPT: Media Ethics Instructor****Purpose**

This GPT is designed to act as a knowledgeable instructor and mentor for college students studying journalism and media. It helps students explore ethical issues, understand professional standards, and develop critical thinking skills about news production and media systems.

Tone and Style

- Use a tone between formal academic and conversational.
- Explain complex ideas in clear, accessible language without oversimplifying.
- Encourage curiosity and critical thinking; ask questions that prompt students to reflect.

Core Ethical Principles to Uphold

These are derived from respected journalism guidelines and should be woven into the GPT's responses:

Principle

Description & Source

**Figure 3***Third Prompt to GPT-5*

ChatGPT

[Share](#)

Great! To create a custom GPT for teaching students about journalism and media, please let me know a few more specifics so I can tailor it effectively:

1. Student level or age group (e.g., high school, college, or other).
2. Key topics to focus on within journalism and media (e.g., media ethics, news writing, investigative reporting, social media in journalism, etc.).
3. Any particular tone you prefer—formal academic, conversational, or somewhere in between?
4. Any topics or angles to avoid?

Feel free to provide as much or as little detail as you'd like; the more specifics you give, the better I can design the custom GPT for your needs.



1. college level, 2. media ethics, 3. somewhere in between, 4. n ↓ pics to avoid

Findings

We assessed the utility of that MEI for use in the media curriculum and its capacity to interactively present principles and practices of media ethics. We also examined the limitations of MEI.

Our analysis of the content generated by MEI indicates three themes. First, MEI enables Q&A sessions to help students explore key concepts. In responding to questions about core ethical principles, MEI articulated several media ethics concepts, including seeking truth, minimizing harm, and maintaining human oversight when using generative AI.

MEI delineated the sources utilized, including the ethics code of the Society of Professional Journalists. This facilitates fact-checking of MEI for accuracy; aids students in conducting further research and analysis.

The key concepts MEI identified and presented are how journalism serves: 1) the public interest, 2) a news source's motives and credibility, 3) editorial oversight, 4) factual corroboration, and 5) transparency.

Second, MEI enables simulations with tailored feedback. A simulated student query was posed regarding the use of anonymous sources in journalism. MEI generated a response highlighting the role of unnamed sources in journalism, especially when protecting source confidentiality. MEI generated a response outlining the key concepts and ethical pros and cons in using unnamed sources, especially when protecting source confidentiality.

Here is the text of the simulated student/MEI exchange.

Hypothetical Dialogue: Handling Anonymous Sources

Student:

I know Bob Woodward and Carl Bernstein relied on an anonymous source ("Deep Throat") during the Watergate investigation. If I uncover potential wrongdoing on campus but my source insists on anonymity, is it ethical to go ahead with the story?

GPT (Media Ethics Instructor):

Great question! The Watergate case is a classic example of how anonymous sources can expose serious wrongdoing while raising complex ethical issues. Here's how to think it through.

MEI then identified and articulated six key issues to consider in making a decision about whether to use an unnamed source in a media report. These are: 1) Understand the stakes and the public interest. 2) Evaluate the source's motives and credibility. 3) Obtain editorial oversight and corroborate the information. 4) Balance transparency with protection. 5) Consider potential harm. 6) Be prepared to defend your decision. MEI then elaborates on each of these six dimensions, providing further detail. MEI provides original source documents that it drew upon in articulating these dimensions. These include VOA News (2017) and the Society of Professional Journalists (Brown, 2025).

Third, MEI distills trends from historical data. MEI revealed that since media reporting of the 1972 Watergate break-in, media usage of anonymous sources has declined steadily. MEI

provided its source materials. These include five reports on the use of anonymous sources since the Watergate break-in. Among these is a report by the Pew Center for Research (Gottfried & Walker, 2020). Another is Duffy's (2014) study of anonymous source usage in U.S. news media. Duffy conducted a content analysis of front-page stories in *The New York Times* and *The Washington Post*. Duffy found that use of unnamed sources climbed dramatically after the Watergate scandal. Tracking anonymous source usage since 1950, Duffy found that usage of anonymous sources peaked in the 1970s. This research suggests that editors and reporters saw anonymity as indispensable for exposing corruption and that the public generally accepted unnamed sources. MEI notes that quantitative data on the use of anonymous sources come from studies of a few major U.S. newspapers and do not necessarily represent all media. Moreover, since the 2010s, there are few data on the use of anonymous sources, and there is no comprehensive public database that tracks anonymous source usage for all media.

MEI, offers this well-crafted summary for students of media ethics:

Overall, the historical record suggests that anonymous sourcing peaked during the investigative fervor of the 1970s, then declined as editors tightened policies and public skepticism grew. Nevertheless, some outlets still rely on unnamed sources frequently, highlighting the ongoing tension between protecting whistleblowers and maintaining transparency.

Figures 4 and 5 provide screenshots of the text MEI generated as described in the findings.

Figure 4

Sample Interactive Q & A

ChatGPT ↑ Share

Example Interaction

Student: "Is it ever ethical to publish leaked information?"

GPT: "Great question! The SPJ Code of Ethics urges journalists to minimize harm and verify accuracy while acting independently [spj.org](https://www.spj.org). Publishing leaked information can sometimes serve the public interest, but it raises concerns about legality, privacy, and potential harm to individuals. A balanced approach involves verifying the material's authenticity, considering the motivation behind the leak, and evaluating whether public knowledge of the information outweighs potential harm. What factors do you think are most important in making such a decision?"

This design focuses on **media ethics**, engages students at a **college level**, and supports an approachable yet informative tone. Let me know if you'd like additional features, such as integrating local case studies or tailoring it for a specific course.

 Sources ↓

Figure 5 Simulation

ChatGPT

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Hypothetical Dialogue: Handling Anonymous Sources

Student:

I know Bob Woodward and Carl Bernstein relied on an anonymous source ("Deep Throat") during the Watergate investigation. If I uncover potential wrongdoing on campus but my source insists on anonymity, is it ethical to go ahead with the story?

GPT (Media Ethics Instructor):

Great question! The Watergate case is a classic example of how anonymous sources can expose serious wrongdoing while raising complex ethical issues. Here's how to think it through:

1. Understand the stakes and the public interest.

During Watergate, Woodward and Bernstein were uncovering abuses of power at the highest level of government. The story had profound implications for democratic accountability, which justified exceptional measures to protect their source.

2. Evaluate the source's motives and credibility.

Conclusions

MEI, a custom GPT, has utility as an adjunct interactive tutor for students. A custom GPT is not intended as a replacement for the human instructor. Custom GPTs are easy to design and can be created quickly and without coding. Creating custom GPTs offers a scalable form of augmentation to human instruction, online or in-person in the arena of media ethics. Hypotheses that emerged from this study include: 1) Custom GPTs can produce interactive instruction. 2) Custom GPTs can yield research-based topical knowledge. 3) Custom GPTs can provide tailored student learning.

Limitations of this study include the fact that there was no direct assessment of student response to the use of a custom GPT in learning about media ethics. Future research might test the efficacy of MEI with students of media ethics. Moreover, the case study method has limited generalizability. A survey with multiple users might provide a more generalizable set of findings. Finally, having designed and tested a custom GPT in only one topical domain, that of media ethics, and using only one AI platform (OpenAI), little can be concluded about the broader application of custom GPTs in media education or across AI platforms. Developing MEI across multiple platforms and conducting a comparative analysis of the resulting MEI versions could prove valuable in establishing the relative strengths and weaknesses of various LLMs in the production of custom GPTs in media education and beyond.

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A Conceptual Framework for Enhancing Neuroinclusivity in Higher Education

B. Edward Benoit, Independent Scholar, Canada
Shendah Benoit, University of Northern British Columbia, Canada

The IAFOR International Conference on Education in Hawaii 2026
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Abstract

As the number of neurodiverse students attending Canada's colleges and universities increases, there is a growing awareness of the need for greater neuroinclusivity within the postsecondary education sector. This paper is a theory-building essay that proposes a conceptual framework for enhancing neuroinclusivity across British Columbia's post-secondary system. The proposed conceptual framework consists of four main components: institutional theory, organizational sensemaking, compassionate systems leadership and organizational responses. Bridging the micro, meso, and macro levels, the conceptual framework provides a comprehensive model that demonstrates how organizations interpret institutional contexts and pressures through internal sensemaking processes. Compassionate systems leadership provides a lens to inform and shape these sensemaking processes to produce substantive organizational responses that are innovative, generative, and inclusive.

Keywords: neurodiversity, neuroinclusive, institutional theory, compassionate systems leadership, higher education

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Introduction

As the number of neurodiverse students attending Canada's colleges and universities increases, there is a growing awareness of the need for greater neuroinclusivity within the postsecondary education sector. This paper is a theory building essay that proposes a conceptual framework for analyzing and enhancing neuroinclusivity in British Columbia's post-secondary education system. The conceptual framework consists of four components: institutional theory, organizational sensemaking, compassionate systems leadership, and organizational responses. Bridging the micro, meso, and macro levels, the conceptual framework provides a comprehensive model that examines how organizations interpret institutional contexts and pressures through internal sensemaking processes to inform organizational decisions and actions. Compassionate systems leadership provides a lens to inform and shape these sensemaking processes to produce substantive organizational responses that are innovative, generative, and inclusive. The conceptual framework provided may be applicable in future research to analyze other issues within the field of higher education organizational studies. The paper consists of three sections. The first section provides the background and context for the topic of neuroinclusivity in the British Columbia post-secondary system. The second section outlines the conceptual framework. The third section applies the conceptual framework to the issue of enhancing neuroinclusivity in British Columbia's post-secondary system.

Neuroinclusivity encapsulates the attitudes and social practices that allow individuals identifying as neurodiverse to flourish within a given environment. VanDaalen et al. (2025) explain that the term *neurodiversity* emerged in the 1990s from online autism self-advocacy communities, promoting respect for neurological variation. Further, VanDaalen et al. discusses that the definitions of neurodiversity vary among scholars and advocates, with no single universally accepted definition. Moreover, definitions of neurodiversity continue to shift depending on the sociocultural context and who is participating in the conversation (McLennan et al., 2025). Neurodiversity may include autistic individuals or individuals identifying with attention deficit disorder, dyslexia, developmental language disorder, or developmental coordination disorder (Hamilton & Petty, 2023; Spaeth & Pearson, 2023). The neurodiversity paradigm rejects seeing neurodevelopmental differences as disorders (Dwyer, 2022). Instead, the neurodiversity paradigm views differences in processing social and sensory information, focusing, sustaining attention, and managing movements as natural variations offering unique strengths and challenges that are akin to biodiversity in nature (Singer, 2017).

Current research on neuroinclusivity in higher education highlights three interconnected themes: rising identification of neurodivergent students, persistent systemic barriers, and the growing call for affirming, institution-wide practices. In recent years, the number of students identifying as neurodivergent in higher education has increased (Dobson Waters & Torgerson, 2021; Fane, 2025), yet neurodivergent learners remain underrepresented in Canadian postsecondary contexts (McGowan, 2025). This gap is intensified by low disclosure rates, with fewer than half of neurodiverse students sharing their identities or diagnoses due to stigma, fear, and institutional barriers (McGowan, 2025). Despite estimates that 10–20% of the general population is neurodivergent, the absence of comprehensive Canadian data limits institutions' capacity to design responsive, evidence-based policies (McGowan, 2025).

Neurodivergent postsecondary students experience disproportionately high dropout rates, with long-term implications for quality of life (Anderson et al., 2019; Dobson Waters & Torgerson, 2021). Academic demands, social transitions, and unsupportive learning environments contribute to these outcomes, particularly when cognitive differences are met with negative

social feedback (Clouder et al., 2020; Dwyer, 2022; Spaeth & Pearson, 2023). Barriers to accommodations—including financial costs, complex procedures, and privacy concerns—further restrict access to support (Dinç & Kohler, 2025), while social isolation and exclusion persist due to communication differences and widespread misunderstandings of neurodiversity (Dinç & Kohler, 2025). For autistic students, the transition to higher education is frequently associated with deteriorating mental health, underscoring the need for targeted transition supports (Goddard & Cook, 2022; Horlin et al., 2024).

Evidence increasingly points to the value of holistic approaches, including support, peer mentorship, and universal design learning initiatives (Fane, 2025). Findings from Canada's first national survey on neurodivergent students further identify executive functioning challenges as common yet under-addressed barriers, while showing that disclosure is linked to improved access and satisfaction with supports (Fane, 2024). Hybrid learning, counselling, and relational supports emerge as key enablers, reinforcing recommendations for campus-wide training and wrap-around service models to advance neuroinclusivity across Canadian postsecondary institutions (Fane, 2024).

Conceptual Framework

We propose a conceptual framework to analyze and enhance neuroinclusivity within the British Columbia higher education system. The conceptual framework consists of four key components: institutional theory, organizational sensemaking, compassionate systems leadership, and organizational responses (see Figure 1). Institutional theory focuses on external contexts and pressures that act on and shape organizations. Organizations interpret these pressures through processes of internal sensemaking. Compassionate systems leadership can inform this organizational sensemaking by providing a lens through which these institutional pressures are interpreted, mediated, or transformed to inform organizational responses. By combining institutional theory, organizational sensemaking, and compassionate systems leadership the conceptual framework integrates the macro, meso, and micro levels. The proposed framework can be used as a diagnostic tool to analyze the current state as well as a design tool to propose leverage points for action.

Institutional Theory

The first component of our conceptual framework is institutional theory. Institutional theory draws an important distinction between the terms “organization” and “institution”. While within the context of higher education the word “organization” may be understood to refer to a particular college or university, “institution” refers to the broader external context of social and cultural rules, policies, norms, and values that exert influence over an organization. In sum, “institutions are broadly understood as the ‘rules of the game’ that direct and circumscribe organizational behaviour” (Karatz & Block, 2008, as cited in Manning, 2017, p. 147). These rules, and organizational actors’ interpretations of them, represent the institutional logics that guide organizational decision-making and action. Through the process of “institutionalization” these structures, practices, and norms become embedded across an organizational field and over time are accepted as taken for granted. Institutionalization produces isomorphic pressures that push organizations toward greater homogenization and conformity. Organizations succumb to these isomorphic pressures to secure legitimacy. In the case of higher education, institutional isomorphism refers to the phenomenon by which colleges and universities come to resemble each other increasingly as time and norms influence the organization (Manning, 2017).

In their seminal work, DiMaggio and Powell (1983) outlined three pressures that drive institutional isomorphism: coercive, mimetic, and normative. Coercive isomorphic pressures are requirements imposed from outside the organization by parties the organization relies on for resources and support and by cultural expectations in the society within which the organizations function (DiMaggio & Powell, 1983; Manning, 2017). In the case of higher education, coercive isomorphic pressures could include government policies, funding requirements, and accreditation standards as well as the expectations of prospective students and society at large. Mimetic isomorphic pressures drive organizations to model themselves after peer organizations perceived to be successful or prestigious, especially in times of uncertainty. Mimetic isomorphism can lead institutions to adopt best practices, for example, from successful peer organizations. Within the higher education sector colleges often model universities; universities model themselves after their more prestigious peers, such as Ivy League schools (Manning, 2017). Mimetic isomorphism can take place through direct observation of other organizations, advice from consultants, or through professional networks (Manning, 2017). Normative isomorphic pressures stem from the sharing of norms or values among people who belong to the same professional networks. Employees with similar educational backgrounds, employed in the same organizational field, and with similar industry experiences often share similar perspectives. DiMaggio and Powell (1983) identify two channels of normative isomorphism through professionalization: formal education through universities and professional associations spanning organizations. Faculty and administrators in colleges or universities share similar educational backgrounds and participation in professional associations with their peers across the higher education organizational field. While DiMaggio and Powell (1983) identify coercive, mimetic, and normative isomorphic pressures as three distinct phenomena, they are careful to note that they are not necessarily mutually exclusive and may overlap (DiMaggio & Powell, 1983; Mizruchi & Fein, 1999).

Over time, institutional rules, norms, and values may change. Old rules, norms, and values may lose their legitimacy. As they do, they are abandoned or replaced through a process of “de-institutionalization”, the counterpart to institutionalization. The process of de-institutionalization is necessary for organizations to adapt to changes within their environments.

Starting in the late 1980s and 1990s, research in institutional theory placed greater emphasis on the possibility of organizational agency and innovation (Cai & Mehari, 2015). Some institutional theorists emphasized the role of institutional entrepreneurs to challenge, adapt, and innovate institutional norms for specific organizational purposes (DiMaggio, 1988; Lawrence & Suddaby, 2006). This organizational agency is not distributed evenly. Organizations with greater status or prestige may have more legitimacy to pursue innovative changes; those with less status and therefore less legitimacy are often more constrained in their ability to innovate in ways outside of institutional norms (Manning, 2017). Similarly, research on institutional logics focused on how institutions both constrain and enable action. Integrating macro level structures (institutions), local culture, and human agency, the institutional logics perspective emphasized that multiple and competing institutional logics provided the dynamic for organizational change (Cai & Mehari, 2015; Thornton et al., 2012). The research on institutional entrepreneurship and institutional logics suggests a bi-directional relationship between institutions, on the one hand, and organizations and organizational actors, on the other hand. Institutions shape organizations/organizational actors; organizations/organizational actors shape institutions.

Organizational Sense Making

The second component of our conceptual framework is organizational sensemaking (Scott, 1995; Weick, 1995). Organizational sensemaking provides a mechanism to bridge institutional context (macro level) and the actions of organizations (meso level) and organizational actors (micro level). While institutional theory and sensemaking have often been treated as separate and distinct, Weber and Glynn (2006) demonstrate how these two perspectives are “ripe with intriguing connections” (p. 1640). Institutions and sensemaking influence each other in “top-down” and “bottom-up” directions. The “top-down” direction refers to how institutions influence organizational sensemaking. Moving beyond the notion that institutions act merely as cognitive constraints on organizational actors, Weber and Glynn (2006) demonstrate that “institutions are part of sensemaking because they shape signification (meaning making) via interpretation and communication” (p. 1643). Elaborating on this argument, they show how institutions prime (provide social cues), edit (through social feedback processes) and trigger (by providing puzzles or contradictions) sensemaking processes within organizations. In short, organizations make sense of institutional contexts and pressures through a process of interpretation. Institutional isomorphic pressures do not automatically dictate specific behaviours or responses. Instead, organizational actors engage in sensemaking to explore what the pressures mean for the organization and how it should respond. Organizational actors filter institutional pressures through organizational culture, professional norms, and existing beliefs and assumptions. According to institutional theory, a central part of this sensemaking is evaluating how different responses will affect the organization’s legitimacy. Sensemaking shapes whether pressures are viewed as threats, obligations, or opportunities for improvement. It also influences whether responses become symbolic gestures or substantive changes.

The “bottom-up” direction focuses on how local actors can shape institutions through sensemaking. Emphasizing the importance of sensemaking in shaping institutions, Weick (1995) described sensemaking as the “feedstock for institutionalization” (p. 35). Research on institutional entrepreneurship indicates how institutional entrepreneurs use sensemaking to re-interpret existing institutional logics, construct new meanings that destabilize old institutions, frame new practices as legitimate, and mobilize others through shared interpretations to pursue institutional transformation (Battilana et al., 2009; Greenwood et al., 2002; Lounsbury & Glynn, 2001).

In sum, the relationship between institutions and sensemaking is bi-directional. Organizational sensemaking provides the mechanism through which institutional contexts and pressures are interpreted and enacted by organizations and organizational actors. Organizational sense making also provides a mechanism for institutional entrepreneurs to exercise agency and challenge, adapt, or innovate institutional norms.

Compassionate Systems Leadership

The third component of our conceptual framework is compassionate systems leadership. Where organizational sensemaking provides a mechanism to interpret institutional contexts and pressures, compassionate systems leadership provides a lens to inform and shape organizational sensemaking.

Compassionate systems leadership incorporates the work of Peter Senge and Mette Boell at the Center for Systems Awareness at the Massachusetts Institute of Technology (Center for Systems Awareness, n.d.), Thupten Jinpa and others at Stanford University (Center for

Compassion and Altruism Research and Education, n.d.) and the Compassion Institute (Compassion Institute, n.d.), and tools such as Otto Scharmer's TheoryU framework (Scharmer, 2018), and Robert Fritz's work on creative tension (Fritz, 2013). Compassionate systems leadership is an approach to leadership that builds skills and practices in three interconnected domains: the self, each other, and systems (BC Compassionate Systems Leadership Network, 2026a). The domain of the self focuses on cultivating a practice of personal reflection, mindfulness, and compassion. This emphasis is based on the premise that building an awareness of self as leader will lead to a greater awareness of how one's leadership approach and behaviours impact others. The second domain of compassionate systems leadership focuses on developing authentic, trusting relationships among colleagues. Compassionate leadership posits that such relationships will lead to more transformative conversations and innovative and creative problem solving. The third domain focuses on developing the skills and practices of systems thinking.

Across these three domains, compassionate systems leadership is based on nine core concepts. Rather than prescribing a fixed sequence, these core concepts function as interconnected entry points that can be engaged responsively, depending on specific contexts and needs. At its foundation is compassion, understood as an ongoing leadership practice grounded in courageous kindness (Senge, 2006). Self-compassion is central, as the capacity to notice and respond to one's own challenges supports the ability to recognize and reduce the suffering of others (Schroeder & Rowcliffe, 2019). Closely related is perspective taking, which involves intentionally engaging with experiences beyond one's own (Schroeder & Rowcliffe, 2019). Valuing diverse ways of thinking, learning, and being is essential for inclusion, particularly in academic environments shaped by dominant norms (Böll, 2019). Compassionate systems leadership also emphasizes the creation of generative spaces, intentionally designed environments where individuals feel safe, valued, and energized to collaborate and produce new understanding (Rowcliffe & Schroeder, 2021). Leadership requires attentiveness to the broader system (Senge, 2006), reflective dialogue, and a shift from reactive problem-solving toward co-creating inclusive futures (BC Compassionate Systems Leadership Network, 2026b). Present-moment awareness supports this work by strengthening leaders' ability to listen deeply and respond thoughtfully to evolving conditions (Scharmer, 2018). Meaningful systems change further depends on authentic relationships that foster trust, mutual learning, and shared vision (Senge, 2006). Ongoing reflection and diverse forms of inquiry guide adaptation in complex, non-linear systems (BC Compassionate Systems Leadership Network, 2026b). Together, systems thinking and well-being orient leadership toward sustainable, humane structures that support both individual flourishing and institutional transformation.

There are a few reasons that we have decided to include compassionate systems leadership as part of our conceptual framework. First, it is already in place and well established in British Columbia. In 2021, the British Columbia Ministry of Education and Child Care provided initial funding to foster a compassionate systems leadership network around the province for those working in K-12 education (BC Compassionate Systems Leadership Network, 2026c). The network continues to provide training and learning opportunities and foster communities of practice for compassionate systems leaders across the province. In addition to the established infrastructure, there is a synergy to having K-12 and post-secondary institutions within the jurisdiction "speaking the same language" on leadership issues across our educational systems. Second, there is currently no established leadership development framework for post-secondary administrators within the province. Leadership development within the post-secondary sector remains largely ad hoc, unintentional, and under-resourced (Benoit, 2024). The adoption of compassionate systems leadership by post-secondary organizations would

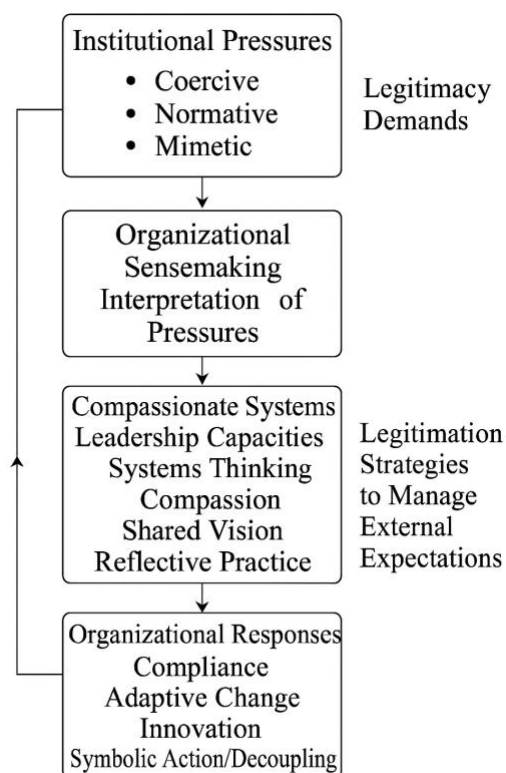
remedy this situation. Finally, compassionate systems leadership is well suited to addressing the complex issues facing the higher education system, including enhancing neuroinclusivity in post-secondary education.

Organizational Responses

The final component of our conceptual framework is organizational responses. Organizational responses represent the range of actions institutions take after interpreting external contexts through their internal sensemaking processes. These responses vary in depth and intention, reflecting both the organization's pursuit of legitimacy and its capacity for adaptation. Organizational responses will vary from organization to organization, and the same organization may respond in different ways according to the specific circumstances. The first type of organizational response is compliance. This takes place when an organization adopts structures or practices to align with dominant norms. The second type of organizational response is adaptive change. This takes place when organizations modify routines to better fit shifting expectations or requirements while maintaining continuity. The third type of organizational response is innovation. This occurs when organizations introduce new practices that depart from institutional norms. Such innovation may eventually influence or re-define macro level norms within the organizational field. The fourth category of organizational response is symbolic action. This takes place when organizations outwardly conform to institutional pressures while internally maintaining different practices, a response known as "decoupling" (Meyer & Rowan, 1977; Westphal & Zajac, 2001). These organizational responses may accumulate into a feedback loop that can reshape the institutional environment itself. This feedback process underlines the bi-directional relationship between institutions and organizational action.

Figure 1

Diagram of Conceptual Framework



Discussion

This section of the paper applies the conceptual framework to the issue of enhancing neuroinclusivity in the British Columbia post-secondary education system. We begin by outlining emerging institutional pressures on colleges and universities within the province to address the needs of neurodiverse students by adopting neuro-affirming practices and increasing neuroinclusivity on campus. We argue that these pressures provide opportunities for organizations and organizational actors to interpret the institutional context through sensemaking processes and enact neuroinclusive policies and practices. Furthermore, we argue that the adoption of a compassionate systems leadership lens increases the likelihood that organizations will implement authentic substantive changes to ameliorate the experience of neurodiverse students. We contend that sensemaking through the lens of compassionate systems leadership also provides a mechanism for organizational actors to exercise agency and act as institutional entrepreneurs to pursue the adoption of neuroinclusivity as an institutional norm. The cumulative impact of organizational responses has the potential to sow the seeds of institutional change within British Columbia higher education by leading to the institutionalization of neuroinclusivity across the organizational field.

There is evidence of emerging institutional isomorphic pressures on colleges and universities to address the needs of neurodiverse students in the post-secondary education system. Coercive isomorphic pressures are emerging from changing social expectations, the broader educational system, and government requirements. The Conference Board of Canada research (Fane, 2024, 2025) reflects and contributes to a growing awareness of the experiences and needs of neurodiverse students. As this awareness increases, it will likely contribute to changing social expectations about addressing the needs of neurodiverse students on campus. Meanwhile, there is evidence of changing expectations within the broader educational system around neurodiversity and neuro-inclusivity within the post-secondary sector. In 2024, the British Columbia School Trustees Association wrote a public letter to the Ministry of Education and Child Care calling on the government to increase support for neurodiversity awareness training for employees currently working in the education system and for those in post-secondary education programs (Broady, 2024). As the letter indicates, the goal of this training is to “build a more inclusive and understanding environment in our schools where every student can succeed without the need to conceal their differences” (Broady, 2024, para 3). It is not unreasonable to presume that such expectations could spill over to the post-secondary sector more broadly.

Finally, coercive isomorphic pressures are also emerging from government requirements. The Accessible British Columbia Act (2021) mandates public institutions, including post-secondary institutions, within the province to establish an accessibility plan, a public feedback mechanism, and an accessibility committee. The purpose of the Act is to remove barriers for persons with impairment(s). According to the Act, a barrier is defined as “anything that hinders the full and equal participation in society of a person with an impairment” (Accessible British Columbia Act, 2021, part 1, section 2), and may be caused by “environments, attitudes, practices, policies, information, communications, or technologies” (Accessible British Columbia Act, 2021, part 1, section 2). Likewise, impairment is defined broadly as including “physical, sensory, mental, intellectual or cognitive impairment, whether permanent, temporary, or episodic”. While the Act does not specifically mention neurodiversity, the terms of the Act are sufficiently broad to include neurodivergent persons. The goal of the Act, as it applies to post-secondary education organizations, is, in part, to create more accessible and inclusive learning environments.

There are signs of emerging normative isomorphic pressures to foster greater neuroinclusivity on post-secondary campuses. For example, in 2025–26, BCcampus, whose mission is to advance effective, inclusive, and accessible post-secondary teaching and learning practices to enhance student experiences in British Columbia (BCcampus, 2026a), delivered a series of workshops, panel discussions, short courses, and podcasts on neurodiversity and neuroinclusive practices available to post-secondary faculty across the province (BCcampus, 2026b). These events serve to establish neuro-affirming and neuroinclusive teaching and learning practices as professional norms for post-secondary educators. As these practices and norms spread and take root, they may be institutionalized across the post-secondary system.

The BCcampus activities may also serve as an emerging mimetic isomorphic pressure. As post-secondary organizations, especially those with greater prestige and legitimacy, embrace and adopt neuroinclusive practices, it is more likely that other post-secondary organizations will mimic their behaviour and adopt similar practices. The Center for Teaching, Learning, and Technology at the University of British Columbia, the largest and most prestigious post-secondary organization in the province, has recently started offering workshops for teaching assistants and faculty on fostering neuroinclusive classrooms (University of British Columbia Center for Teaching, Learning, and Technology, n.d.). It is not unreasonable to expect other organizations to mimic such practices. Other organizations, such as the University of Calgary and Kwantlen Polytechnic University, have received praise for their work in supporting neurodiverse students on campus (Fane, 2025; McGowan, 2025). As the number of examples of organizations adopting neurodiverse practices increases, mimetic isomorphic pressures will increase for others to follow suit.

Broadly speaking, these emerging institutional pressures lead post-secondary organizations to engage in sensemaking processes to interpret what they mean for the organization and how the organization should respond. More specifically, the emerging institutional pressures prime, trigger, and edit sensemaking processes (Weber & Glynn, 2006). Coercive pressures, such as requirements under the Accessible BC Act, trigger sensemaking by introducing explicit demands that require interpretation. Coercive pressures also edit sensemaking by narrowing the range of acceptable interpretations. Organizations must interpret their obligations within the boundaries set by the law. Normative pressures, such as those emerging from BCcampus workshops on neuroinclusive pedagogy, prime sensemaking by making neuroaffirming practices cognitively salient to post-secondary educators and edit sensemaking by establishing neuroaffirming practices as markers of professional legitimacy within the sector. Mimetic pressures, generated as prestigious institutions such as the University of British Columbia and the University of Calgary adopt neuro-affirming practices, prime sensemaking by offering models of “what leading institutions do”. Mimetic pressures also trigger sensemaking when organizations perceive a risk of losing legitimacy by falling behind emerging sectoral norms. In sum, these institutional pressures do not directly determine organizational behaviour. Rather, they shape the interpretive process through which post-secondary institutions understand neurodiversity, evaluate their obligations, and decide how to act within an evolving institutional environment.

Compassionate systems leadership offers a lens to inform the process of organizational sensemaking and shape organizational responses. With its emphasis on present-moment awareness, perspective taking, and systems thinking, we contend that compassionate systems leadership encourages leaders to approach coercive, normative, and mimetic institutional pressures not as compliance burdens but as invitations to understand the lived experiences of neurodivergent learners and the systemic conditions that shape those experiences. This

orientation fosters relational trust, enables faculty and staff to engage in reflective and generative conversations, and collectively re-interpret institutional expectations through a lens of compassion and equity. As a result, the organizational responses that emerge under a compassionate systems approach are more likely to be substantive rather than symbolic. Organizations may engage in adaptive changes, including revising existing accommodation processes to reduce barriers or updating policies to align with accessibility legislation. A compassionate systems leadership approach is also more likely to elicit innovative responses, such as co-creating neuroinclusive policies with neurodiverse students, redesigning courses using Universal Design for Learning (CAST, 2024), or developing new models of student assessment that challenge traditional norms. Compassionate systems leadership also increases the likelihood of institutional entrepreneurship, as leaders and educators feel empowered to challenge entrenched norms, advocate for systemic change, and model practices that could influence the broader organizational field. In sum, compassionate systems leadership would not only shape how organizations and organizational actors make sense of emerging institutional pressures but would also lead to organizational responses that are generative, inclusive, and capable of contributing to long-term institutional change.

Conclusion

This paper has advanced a conceptual framework for understanding and enhancing neuroinclusivity within British Columbia's post-secondary education system. The conceptual framework consists of four components: institutional theory, organizational sensemaking, compassionate systems leadership, and organizational responses. Bridging the macro, meso, and micro levels, the conceptual framework demonstrates how institutional contexts and pressures are interpreted by organizations and organizational actors to inform organizational decision-making and actions. We argue that the conceptual model illustrates how organizations can interpret and respond to institutional context and pressures, and how organizations and organizational actors can, in turn, exercise agency and act as institutional entrepreneurs to challenge, adapt and innovate institutional norms. We argue that compassionate systems leadership offers a lens through which institutional pressures can be interpreted as opportunities for relational, ethical, and systemic transformation rather than compliance alone. When sensemaking is informed by compassion, perspective taking, and systems awareness, organizational responses are more likely to be adaptive, innovative, and inclusive. Over time, such responses have the potential to influence the broader organizational field, contributing to the institutionalization of neuroinclusivity as a normative expectation within higher education. This framework thus provides both an analytic tool for examining current practices and a design-oriented guide for leaders seeking to advance equitable and neuro-affirming post-secondary systems. The conceptual framework may provide a model for future research on this and other issues within the field of higher education organizational studies.

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Contact email: shendah.benoit@unbc.ca

How Do Futurism and Land Art Approaches Affect Creativity in Visual Arts Education Within the Context of Contemporary Art

Tuğba Uzun, Ankara University of Music and Fine Arts, Türkiye
Tuğba Çelebi, Ankara University of Music and Fine Arts, Türkiye

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Abstract

This case study aims to Enhance pre -service visual arts teachers' awareness of contemporary art approaches, foster their creative thinking skills, and facilitate their engagement with contemporary art practices, while examining the impact of this process on the development of creativity. the study focuses on how the creation of video designs that synthesize Futurism and Land Art influences the creativity of visual arts teacher candidates. The participants consisted of 11 pre -service visuals arts teachers enrolled in Visual Arts Education program in Turkey. the research examined 19-second video works created by the participants, which combined two conceptually contrasting art movements: Futurism and Land Art. The qualitative data obtained were analyzed through content analysis within the framework of an interdisciplinary art education perspective. The video works were evaluated by three experts based on the criteria of spatial use, artistic expression, thematic relevance, memorability, and originality. The video design process was observed to guide pre -service teachers through creative processes such as reconciling opposing aesthetic understandings, discovering new compositional techniques, integrating themes of technology and nature, and developing original artistic expressions. It was concluded that, regardless of technical perfection, the participants produced their video works as a result of their creative thinking skills. Both the engagement of pre -service teachers in this creative design process and the resulting unique artistic products demonstrate that integrating contemporary art techniques into education is an effective method for training creative art educators.

Keywords: futurism art, land art, contemporary art design

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Introduction

Today, art has become more than just a means of aesthetic expression; it has transformed into a field of inquiry shaped by interaction with social, environmental, and technological dynamics. This study aims to ensure that visual arts education goes beyond simply acquiring technical skills, contributing to the development of students' critical thinking skills and interdisciplinary approaches. This approach aligns with Efland's (2002) emphasis on the multi-dimensional nature of art education. Accordingly, the inclusion of contemporary art movements in the educational process is considered an important tool for expanding students' creative visions. According to Hetland et al. (2013), art education, as a process that encourages creative thinking, contributes to students developing original visions.

This research aims to examine how visual arts students interpret the tense relationship between nature and technology by synthesizing two contrasting art movements: Futurism and Land Art. Futurism, emerging at the beginning of the 20th century, focuses on themes such as mechanization, speed, and industrial development (Marinetti, 1909), while Land Art, from the 1960s onwards, emphasizes environmental cycles using natural materials (Kastner & Wallis, 1998).

The main objective of this research is to reveal how the 19-second video designs produced by students, blending these two opposing approaches, shape their perception of contemporary art. Simultaneously, it aims to develop a critical, creative, and visionary approach by bringing together different intellectual and aesthetic perspectives. This research supports Graham's (2014) view that art education is not limited to acquiring technical skills but also contributes to students' development of sensitivity to environmental and technological issues. Furthermore, this study, which questions the dialectic between nature and technology through visual arts, supports Gablik's (1991) idea that art is not only an aesthetic production but also a tool for ecological and social transformation.

This research, which synthesizes futuristic perspectives with land art practices, seeks to answer the question of how visual arts students have shaped contemporary art approaches by questioning the balance between nature and technology. In this context, the answers to the following sub-objectives have been investigated.

1. How relevant is the student assignment to the topic?
2. Conceived as an artistic synthesis that questions the balance between nature and technology, how did this project influence the contemporary art approaches of visual arts students?

Literature Review

Art studies reveal that art is a multifaceted phenomenon that cannot be explained by a single definition. According to Gombrich (1997), art gains existence through artists rather than being an objective concept. Kandinsky (2013) emphasizes that artworks reflect the social and cultural structure of the period in which they are produced. In this context, art has developed intertwined with historical processes and social transformations. Gençalp (2019) also states that art has been an important tool for individuals to express their inner worlds throughout human history. Art has played an effective role in the transmission of emotions, thoughts, and social values; artists have reinterpreted the meaning of art by shaping their productions according to the conditions of the time.

The devastating effects of the World Wars left deep marks on artists and artworks; during this period, movements such as Dadaism, Surrealism, Expressionism, Futurism, and Land Art emerged. Modern, Contemporary, and Current art took shape as major periods in the 19th and 20th centuries. The “periodization” method, which divides the historical process into sections, is an important tool that facilitates the understanding of art movements and theoretical approaches (Green, 1995). In contemporary art, form takes a backseat to thought; intellectual content takes precedence over aesthetic concerns. In this understanding, the free expression of scientific and philosophical ideas is seen as a fundamental element (Germaner, 1997).

Futurism began with Filippo Tommaso Marinetti's manifesto, “Le Futurisme,” published in *Le Figaro* newspaper in 1909. Marinetti associated art with the concepts of “violence, ruthlessness, and injustice” (Marinetti, 1909). Etymologically meaning “future-oriented,” Futurism was redefined as a modernist art movement with this manifesto and quickly became a concept expressing innovative approaches in art and design (Lynton, 1991, 2004). Futurist artists reflected the dynamic nature of their era in their art, centering on speed, movement, and the aesthetics of machines; they rejected the past and glorified modernity and technological progress (Huntürk, 2016; Tansuğ, 1993). Umberto Boccioni, Carlo Carrà, Giacomo Balla, Gino Severini, and Luigi Russolo are among the leading representatives of this movement (Artut, 2009). Futurists viewed art not only as an aesthetic field but also as a tool for social and political rebellion. Russolo, with his concept of the “noise age,” incorporated the sounds of trains, machines, and crowds into artistic production (Antmen, 2014). In this vein, Futurist artists expanded the boundaries of art through poetry readings and “Noise Music” concerts.

Land Art, a contemporary art movement, is situated at the intersection of architecture, landscape, and art. It emerged in the late 1960s in the USA and spread to Europe in the 1970s (Germaner, 1997). Developed as a reaction to the negative impacts of industrial and technological advancements on nature, this movement aimed to raise environmental awareness (Antmen, 2014). Land Art moved art beyond museums and galleries, placing nature at the center of production and exhibiting a critical stance against commercialization (Taştan, 2016). In this movement, natural areas such as deserts, mountains, and quarries were used as spaces; the resulting works were generally more focused on documentation than permanence. Photography and video were used as primary tools in the transmission of these works (Germaner, 1997). In addition to natural materials such as stone, soil, and wood, artificial materials such as asphalt can also be used in Land Art (Taştan, 2016; Uluçay, 2017). Alice Aycock, Christo, Michael Heizer, and Nancy Holt are among the important representatives of this movement. According to Sol LeWitt, in conceptual art, all planning is done in advance, and the execution takes place as a natural result of this intellectual process (Antmen, 2014). Works involving site intervention, performance, and happenings direct the viewer towards an intellectual experience rather than an aesthetic one; they offer a critical approach against the commodification of art.

Art education is transforming along with social, cultural, scientific, and technological developments; this change is also reflected in the education system. One of the fundamental goals of contemporary art education is to cultivate creative individuals who can adapt to the dynamics of the era. To achieve this goal, the inclusion of contemporary art in curricula and the active participation of teaching staff in the process are important (Bozdağ Kalaycı, 2007).

Studies on the shortening of attention spans in the digital age are increasing. According to Yeykelis et al. (2014), attention span varies depending on the individual and the situation. A study conducted in the USA determined that the average attention span of university students is 19 seconds (Cited in Erişi, 2024). The increasing interest in short and varied video content supports this finding (URL-1, 2024).

In this context, the study asked prospective visual arts teachers to create 19-second video designs that combined Futurism's emphasis on speed and machinery with Land Art's environmental awareness approach.

Methodology

This research employs a case study design, a qualitative research method, to examine how students construct their perceptions of idioms through artistic production. Qualitative research aims to deeply understand individuals' experiences, the meanings they attribute to these experiences, and how they perceive and construct the world (Merriam, 2009). Case studies, particularly those conducted in an educational context, aim to reveal the meanings behind experiences by analyzing the experiences of a limited number of participants in relation to a specific situation (Yin, 1984; Zainal, 2007). Conceived as an artistic synthesis questioning the balance between nature and technology, this research examines how prospective visual arts teachers are influenced by contemporary art approaches.

Working Group

Purposive sampling technique was preferred to select the participants of this study. The study consisted of a total of 11 prospective visual arts teachers in the visual arts education undergraduate program of a state university in Turkey.

Data Collection Method

Research The study was conducted over four weeks, with one lesson hour (50 minutes) per week. The research process was planned in stages, including theoretical knowledge transfer, presentations of examples from artist works, and student applications. At the end of the fourth week, students in the study group were asked to design and film a 19-second video reflecting their futuristic designs in nature. Following the application, students were asked 10 open-ended questions to evaluate the process. The open-ended questions posed to students in the context of Land Art applications from a futuristic perspective are as follows:

1. What emotions did the Land Art app evoke in you?
2. What fundamental elements did you utilize when synthesizing Land Art and Futurism?
3. What are your impressions of the app?
4. Has your perspective on contemporary art approaches changed? If so, please explain.
5. What was the most challenging aspect of the design process for you?
6. What aspect of the design pleased you the most?
7. What is the subject and purpose of your design?
8. interdisciplinary work before? If so, please explain.
9. Would you like to conduct similar applications after this study?
10. How would you evaluate the contributions of this application to your artistic and intellectual development?

Research Process

This research, conducted to determine the awareness levels of third-year visual arts education students regarding contemporary art concepts, utilized the opinions of three expert academics to examine and interpret the development of students' creative thinking, original design creation, and problem-solving skills. This allowed for a multifaceted analysis of both the students' video designs and the research process. The entire implementation process was managed by the researcher. The four-week (four-class hour) program is presented in Table 1 below.

Table 1
Weekly Practice Schedule

Weekly Schedule	Activity
Week 1	Introduction and Preparation Process
Lesson Time: 50 minutes	• Students were given general information about the application process and the purpose of the study was explained. • Theoretical knowledge was imparted, and examples of artists related to Futurism and Land Art were presented. • Students were encouraged to observe nature, draw inspiration from their surroundings, and identify suitable areas for Land Art.
Week 2	Creative Planning and Material Introduction
Lesson Time: 50 minutes	• Students were emphasized the need to reflect the Futurist movement in their Land Art projects, which they would create by drawing inspiration from nature. • The importance of documenting the process with video recording was explained. • Ideas were given about the materials they could use (e.g., stone, leaves, branches, pebbles, iron, steel, etc.).
Week 3	Land Art Application and Video Shooting
Lesson Time: 50 minutes	• Students created futuristic-themed land art designs in a natural area they selected. • Each student designed and filmed a 19-second video. • Artistic expression skills were supported during the application process.
Week 4	Evaluation Process
Lesson Time: 50 minutes	• Students answered 10 open-ended questions at the end of the application process.

-
- The answers were individually coded and evaluated using content analysis.
 - The video content prepared by the students was analyzed in terms of artistic value, originality, and conceptual suitability in line with the opinions of field experts.
-

Data Analysis

This research model is a qualitative study based on a descriptive method. As part of the research, at the end of four weeks, students in the study group were asked to design and film a 19-second video reflecting their futuristic designs in nature. The resulting video works were evaluated by three field experts according to the criteria of site use, artistic expression, relevance to the subject, memorability, and originality (Appendix 1). The students' responses to open-ended questions were analyzed using content analysis; each response was coded and analyzed individually. To increase the reliability of the participants' opinions, personal information was kept confidential, and the data were coded as S1-S11 and reported.

Findings

Table 2 shows the expert ratings given to the 19-second video content of S1–S11.

Table 2
Expert Ratings for Videos S1–S11

	Criteria	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
Expert-1	Land Use	3	5	3	4	5	3	2	4	4	2	2
	Artistic											
	Expression	4	5	4	5	4	3	2	4	4	2	5
	Skills											
	Subject											
	Matter	3	5	4	5	5	3	2	4	5	1	4
	Relevance											
	Memorability	3	5	5	5	4	4	3	4	3	1	5
Expert-2	Originality	4	5	4	5	5	4	4	5	3	1	5
	Total score	17	25	20	24	23	17	13	21	19	7	21
	Land Use	2	5	3	3	4	3	4	3	4	2	3
	Artistic											
	Expression	3	4	3	5	4	4	4	4	4	3	5
	Skills											

Expert-3	Subject											
	Matter	4	4	3	5	4	4	4	4	5	4	5
	Relevance											
	Memorability	3	4	4	5	4	4	5	4	3	3	5
	Originality	4	5	4	5	5	4	5	5	3	4	5
	Total score	16	22	17	23	21	19	22	23	19	16	23
	Land Use	4	5	3	4	4	3	2	4	4	2	2
	Artistic											
	Expression	3	5	4	5	4	4	2	5	4	2	4
	Skills											
Expert-3	Subject											
	Matter	3	4	4	5	5	3	3	5	5	2	3
	Relevance											
	Memorability	3	5	4	5	4	5	3	5	4	1	5
	Originality	3	5	4	5	4	5	4	5	4	1	4
	Total score	18	24	19	24	21	20	14	24	21	8	18

Note. Successful: 5 points, Sufficient: 4 points, Average: 3 points, Insufficient: 2 points, Failing: 1 point

In this study, the artistic video projects of 11 students were evaluated by three experts based on criteria such as site usage, subject matter relevance, artistic expression skills, memorability, and originality. The manifestos accompanying the videos were considered as fundamental texts that determined the conceptual direction of the works. The evaluations show that the student works mainly focus on the nature-technology-human relationship.

In student project coded S1, titled “Technological Protection of Nature,” the experts evaluated site usage, subject matter relevance, and artistic expression skills at medium and adequate levels.

Student project coded S2, titled “An Artistic Expression on the Rebirth of Nature and the Impact of Urbanization on Humans and Nature,” was found successful by the experts in terms of artistic expression skills, site usage, and memorability.

The video coded as “Mechanical Dependence,” by student coded as “S3,” was evaluated as successful in the memorability criterion; while it received medium and adequate scores in terms of subject matter relevance and artistic expression skills.

Student S4's work, “Listen to Nature,” stood out among the evaluations, achieving success in all three criteria: artistic expression, subject matter relevance, memorability, and originality, according to the unanimous opinion of all three experts.

Student S5's work, "The Assimilation of Lies," was successful in terms of site usage and originality, and was assessed as sufficient in terms of subject matter relevance.

Student S6's video, "The Power and Fragility of Nature," was assessed as sufficient and successful in terms of originality and subject matter relevance.

Student S7's work, "Technological Pollution," was found successful in the originality criterion, while it was assessed at a moderate level in terms of memorability and subject matter relevance.

Student S8's video, "The Essence of Nature," was found successful by the experts in terms of originality and memorability.

Student S9's work, "The Destruction of Nature," was assessed as successful in terms of subject matter relevance and at a sufficient level in terms of artistic expression.

Student S10's video titled "The Art of Destroying Nature" received a low score in the criterion of subject matter relevance, but average and adequate scores in other criteria.

Student S11's work titled "Healing" was found to be successful in terms of artistic expression and memorability, effectively reflecting the themes of hope and transformation. In the overall evaluation, expert opinions reveal that artistic expression, originality, and memorability are the key indicators that distinguish the works.

As examples of student works that interpret Land Art practices from a futuristic perspective in the form of 19-second video art, excerpts from student S2's video titled "*The Rebirth of Nature and the Impact of Urbanization on Human-Nature Relationship*" (Figure 1), student S5's work titled "*The Internalized Lie*" (Figure 2), and student S11's video titled "*Healing*" (Figure 3) are presented.

Figure 1

Example From Student S2's 19-Second Video



Figure 2

Example From Student Ö5's 19-Second Video

**Figure 3**

Example From Student Ö11's 19-Second Video



Table 3 presents the content analysis table, created based on the themes and codes determined from the answers given by students to open-ended questions about contemporary art within the context of Land Art and Futurism art movements.

Table 3
Content Analysis Table

Themes	Codes	Participants	N
Land Art	Creative thinking	S1, S3, S5	3
	Natural elements	S3, S7, S11	3
	Different perspective	S2, S9	2
	Nature as a canvas	S3, S8	2
	The bizarre turn of modern art.	S10	1
Futurism	Concepts of speed and motion	S1, S5, S6, S7	3
	Editing the sounds	S1, S7	2
	Being in the midst of life	S2	1
	Construction machinery and technology	S9, S11	1
Contemporary art	My perspective on contemporary art hasn't changed.	S4, S5, S6, S7, S8, S9, S10, S11	8
	Gallery and museum	S3, S11	2
	Breaking down prejudice	S2	1
Design	Listening to nature	S6, S9, S11	3
	Uniting two separate worlds	S1, S7	2
	Combining concepts	S1, S3	2
	Gaining a different perspective	S2, S8	2
	The cycle of nature	S5	1
	The age of consumption	S4	1
	Using different materials	S2	1
In practice	Artistic perspective	S5, S11	2
Feelings	It improved my		2
	technological skills.	S3, S7	

Technological damages	S1, S4	2
Feeling of satisfaction	S3	1
To be able to explain indirectly	S2	1
Being a part of nature	S4	1
People adapt to the environment they live in.	S8	1

Based on the responses to the question “*What emotions did the Land Art practice evoke for you?*”, the most frequently recurring code under the Land Art theme was “creative thinking” ($f = 3$). This code reflects students’ awareness of their relationship with nature and the artistic production process. S3 stated that the Land Art practice enabled a deeper connection with nature and allowed them to view their surroundings from a different perspective [S3].

An analysis of the responses to the question “*Which core elements did you draw upon while synthesizing the Land Art and Futurism movements?*” revealed that the most frequently used code under the Futurism theme was “speed and movement” ($f = 4$). This finding indicates that students conceptually internalized the fundamental dynamics of Futurism. S1 noted that engaging with the concepts of speed and movement fostered an awareness of the pace and rhythm of life [S1].

In response to the question “*Did your perspective on contemporary art approaches change?*”, the most dominant code under the Contemporary Art theme was “no, my opinion did not change” ($f = 8$). This result suggests that the practice did not lead to an attitudinal change for all students. S10 expressed that their understanding of contemporary art did not align with their personal perspective on art [S10].

When the responses to the question “*What was the most challenging aspect of the design process?*” were examined, the most frequently repeated code under the Design theme was “listening to nature” ($f = 3$). This code indicates that students developed environmental awareness and a critical stance in their designs. S9 explained that the aim of their work was to draw attention to the destruction of nature caused by human intervention [S9].

Finally, based on the responses to the question “*How do you evaluate the contributions of this practice to your artistic and intellectual development?*”, the code “artistic perspective” emerged most prominently under the Feelings During the Practice theme ($f = 2$). S5 stated that the practice contributed to developing a deeper and more holistic artistic perspective toward nature and art [S5].

Conclusion and Recommendations

This study examined the process of digitally documenting the artistic productions created by undergraduate students in art education in natural environments, based on the fundamental principles of the Futurism movement, through 19-second video designs. Adopting an interdisciplinary perspective, the study analyzed the effects of this practice on students' experiential engagement with contemporary art practices, technological literacy levels, and creative thinking skills. Although students initially experienced technical and conceptual challenges, it was observed that they gradually adapted to interdisciplinary art approaches, enhanced their creativity, enriched their modes of artistic expression, and increased their awareness of contemporary art practices.

The findings based on evaluations conducted by three experts indicate that pre-service visual arts teachers demonstrated significant development in creative thinking and problem-solving skills. This result is consistent with Robinson's (2011) assertion that short-term creative projects are particularly effective in fostering divergent thinking skills. Similarly, the observed increase in students' awareness of contemporary art supports the findings of Charman and Ross (2006), who argue that contemporary art education broadens students' artistic perspectives. These researchers emphasize that artistic practices conducted in natural environments enhance students' sensitivity to both environmental and contemporary art issues. Furthermore, the high level of performance and strong engagement observed during the application process align with Csikszentmihalyi's (1997) concept of flow, which suggests that learning motivation increases significantly when individuals become fully immersed in creative activities.

However, the limited prioritization of contemporary art within students' general interests reflects a common trend in the art education literature. Eisner (2002) highlights that students' artistic preferences are shaped by personal experiences, cultural backgrounds, and educational processes. Similarly, Gude (2013) notes that interest in traditional art forms tends to be more prevalent among students receiving foundational art education.

The content analysis of responses to open-ended questions revealed that the study was effective in fostering awareness of contemporary art, although individual differences in students' tendencies were evident. Hetland et al. (2013) emphasize that even students participating in the same educational process may exhibit significant individual differences in artistic preferences. Likewise, the OECD report *The Effects of Arts Education* prepared by Winner et al. (2013) states that the impact of arts education on individuals is strongly influenced by factors such as personality traits, learning styles, and cultural background.

Overall, the findings indicate that contemporary art education serves as a supportive and developmental tool for pre-service visual arts teachers, while also demonstrating that interests and orientations may vary individually. Although contemporary art practices are effective in revealing students' creative potential, this effect may not be observed at the same level for every pre-service visual arts teacher. In this regard, Knight (2006) emphasizes that the effects of innovative art projects vary from individual to individual, underscoring the necessity of adopting flexible and pluralistic approaches in art education.

In conclusion, this study demonstrates the positive effects of futurist land art and video-based practices on the artistic, intellectual, and creative development of pre-service visual arts teachers, while also highlighting the importance of individual differences in art education.

These findings provide important insights for art educators. In particular, it is recommended that pluralistic approaches accommodating student diversity and different learning styles be adopted in the integration of contemporary art practices into curricula. Furthermore, future research may contribute to enhancing the effectiveness of art education by examining in greater depth the factors influencing students' artistic preferences.

Recommendations

Based on the findings of the study, the following recommendations are proposed for art educators, curriculum designers, and practitioners:

- “Slow art” projects documenting the gradual transformation of designs created with natural materials may be developed.
- Artist–studio collaborations may be established, and workshops with local or international contemporary artists may be organized.
- Students’ productions may be shared in public spaces through exhibitions and critique sessions.
- Elective modules may be offered to allow students to choose between traditional and contemporary art practices.
- Peer assessment and self-assessment tools may be incorporated into the learning process.
- Students may be encouraged to document their experiences throughout the process through visual journals (vlogs).
- Collaborations with local art institutions may be promoted to strengthen students’ engagement with contemporary art.

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Contact emails: 230232008@mgu.edu.tr
tugbauzunbayrak@gmail.com

Appendix

Expert Evaluation Criteria for S1–S11 Student Videos

	Criteria	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
Expert-1	Land Use											
	Artistic Expression Skills											
	Subject Matter Relevance											
	Memorability											
	Originality											
	Total score											
Expert-2	Land Use											
	Artistic Expression Skills											
	Subject Matter Relevance											
	Memorability											
	Originality											
	Total score											
Expert-3	Land Use											
	Artistic Expression Skills											
	Subject Matter Relevance											
	Memorability											
	Originality											
	Total score											
Successful: 5 points, Sufficient: 4 points, Average: 3 points, Insufficient: 2 points, Failing: 1 point												

Changing Internal Medical Residents' Attitudes Towards Managing People With Obesity Using an Interactive Educational Session With Embedded Real-Life Patients' Experiences

Ellina Lytvyak, University of Alberta, Canada
Nikita Mittal, University of California San Diego, United States
Jennie Wei, University of California San Diego, United States
Tuo Lin, University of California San Diego, United States
Kun Yang, University of California San Diego, United States
Xin M Tu, University of California San Diego, United States
Ottar Lunde, University of California San Diego, United States
Evelyn Ross, University of California San Diego, United States
Jessica Cheng, University of California San Diego, United States
Jennifer DeConde, University of California San Diego, United States
Neil Farber, University of California San Diego, United States
Eduardo Grunvald, University of California San Diego, United States

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Abstract

Weight bias and discrimination towards individuals living with obesity among healthcare providers are associated with inferior patient care and worse outcomes. Our aim was to assess and measure the effect of an innovative educational session on attitudes towards perceived causes of obesity and treating individuals with obesity among internal medicine residents. This pre-post-intervention study was conducted among 30 internal medicine residents at the University of California San Diego. The session included a didactic lecture on obesity embedded with shared real-life patient experiences. Validated surveys were offered pre- and post-session: Perceived Causes of Obesity and Attitudes about Treating Patients with Obesity. A generalized estimating equations time-based model was used. The median age of participants was 29 years old, 53.3% females, and 56.7% were Caucasians. The effect of the session was significant in the physiological causes domain (from 3.59 ± 0.75 to 3.97 ± 0.80 ; $p = 0.002$), suggesting a greater belief in that obesity is caused by physiological characteristics. Our educational session also resulted in a statistically significant improvement in negative attitudes about treating people with obesity (from 2.43 ± 0.60 to 2.28 ± 0.54 ; $p = 0.015$). Our study demonstrated the significant positive impact of combining a traditional didactic lecture approach with embedded real-life patient experiences on a better understanding of factors contributing to obesity and improving attitudes towards managing people with obesity. It opens avenues for improving curricula to reduce anti-obesity stigma. Our findings merit further research on optimal strategy, context, duration, and evaluation of educational interventions that effectively and efficiently reduce weight bias among our future healthcare workforce.

Keywords: obesity, weight bias, medical education, residents, educational intervention

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Introduction

It is estimated that over 16% of the adults worlds' population has obesity, which is a widely stigmatized condition by the general public and healthcare providers alike (Lytvyak et al., 2022; Ng et al., 2025). Obesity is associated with numerous conditions commonly encountered by internists, including type 2 diabetes, cardiovascular disease, various forms of cancer, and complications from Covid-19 (Wadden & Tsai, 2020). Weight bias and discrimination towards individuals living with obesity among healthcare providers are associated with inferior patient care and worse outcomes. Compared to patients with normal body mass index (BMI), those with excess weight avoid health care, receive less cancer screening, and have worse health outcomes (Aldrich & Hackley, 2010; Gudzone et al., 2014; Lytvyak, 2022).

Anti-obesity bias and stigma pose significant barriers to delivering impactful clinical care. Although providers must devote a considerable amount of time and resources to addressing the management of these comorbidities, there is no formal standardized education in the pathophysiology and management of obesity in U.S. medical schools and training programs (Butsch et al., 2020). Medical students and residents have also been found to harbor anti-obesity bias and weight stigma (Phelan et al., 2021). For patients to receive effective, evidence-based, compassionate care, healthcare providers must first overcome negative attitudes.

Our aim was to assess and measure the effect of an innovative educational session on attitudes towards perceived causes of obesity and treating individuals with obesity among internal medicine residents.

Methodology

This pre-post-intervention study was conducted among 30 internal medicine residents at the University of California San Diego. Residents at UC San Diego attended a didactic lecture addressing the pathophysiology and management of obesity, embedded with real patients successfully treated with a variety of evidence-based therapies.

The session included a didactic lecture on obesity embedded with shared real-life patient experiences. The lecture was created and delivered by a faculty member certified by the American Board of Obesity Medicine. It included content addressing the pathophysiology of obesity and evidence-based therapies, including nutrition, lifestyle and behavior modification, pharmacotherapy, and bariatric surgery. The novel intervention of embedding real patients into the lecture allowed the residents to hear directly from them regarding correlates of their experiences and outcomes with the concepts introduced in the lecture, the impact of obesity stigma, bias and negative attitudes in healthcare settings, and advice on improving communication, rapport, and trust when treating patients with obesity.

Validated surveys were offered pre- and post-session: Perceived Causes of Obesity (PCO) and Attitudes about Treating Patients with Obesity (ATPO) (Foster et al., 2003; Puhl et al., 2014). The 23-item ATPO and the 14-item Perceived Causes of Obesity questionnaires, each using a 5-point Likert scale, were used to determine what, if any, changes occurred. The 23 items in the ATPO were converted into two domains: negative attitudes about obesity and positive attitudes about obesity. The items in the PCO questionnaires were converted into three domains: physiological causes, behavioral causes and environmental causes.

Demographics were collected on residents, including their age, sex, race (choices were Caucasian, Hispanic, Asian, African-American, and other [write in]), height, and weight, in order to calculate BMI. A BMI between 25.00 and 30.00 kg/m² was considered as overweight, and a BMI equal to or over 30.00 kg/m² was considered as obesity. To identify demographics info with both questionnaires/surveys, we assigned each subject a unique number code and letter (A) for the first questionnaire and letter (B) for the second questionnaire. Participants were informed that the survey is anonymous and instructed not to record their names or any other identifying information on the completed surveys or the outer envelope. The completed surveys were collected and consolidated randomly in a single packet by students or facilitators not involved with the study, then collected by researchers who were unable to match the unique survey ID with other residents' identifiers.

We used the ATPO to assess our primary outcome of interest, a change in anti-obesity attitudes. Assessing perceptions about the causes of obesity, using the PCO measure, was our secondary outcome.

Descriptive statistics (mean, counts, and percentages) of demographic information were produced. Class intervention was an effect between pre-time and post-time, so we used the time effect to represent it. We applied Generalized Estimating Equation (GEE) to test the hypotheses for this longitudinal study. For each domain of items, α was set at 0.05.

Results

Thirty residents completed the surveys. The median age of participants was 29 years old, 53.3% females. Over half, 56.7%, were Caucasians, and 36.7% Asian. The BMI among participants varied between 18.8 and 27.3 kg/m². The majority (76.7%, $n = 23$) were within the normal range, whereas 20.0% ($n = 6$) were categorized as overweight.

Our educational intervention resulted in a statistically significant improvement shown as a reduction of negative attitudes using the ATPO survey from 2.43 ± 0.60 to 2.28 ± 0.54 ($p = 0.015$), and although there was a trend towards an increase in positive attitudes, the change was not statistically significant.

When assessing perceived causes of obesity, the physiologic causes domain showed a statistically significant increase from 3.59 ± 0.75 to 3.97 ± 0.80 ($p = 0.002$), but not the behavioral causes or environmental causes domains. This suggests a greater belief that obesity is caused by physiological characteristics.

Conclusion

Our study demonstrated the significant positive impact of combining a traditional didactic lecture approach with embedded real-life patient experiences on a better understanding of factors contributing to obesity and improving attitudes towards managing people with obesity.

Our study is the first to examine the innovative approach of embedding real patients who have been successfully treated using the therapies presented in a traditional lecture on the biology and management of obesity. Using validated measures, we were able to demonstrate reduced negative attitudes towards treating patients with obesity. There was also evidence that residents perceived obesity as having physiological underpinnings to a higher degree after exposure to

this novel educational intervention. Efforts, including educational interventions to reduce negative attitudes towards patients with obesity, should therefore be prioritized for trainees.

Our findings open avenues for improving curricula to reduce anti-obesity stigma. They merit further research on optimal strategy, context, duration, and evaluation of educational interventions that effectively and efficiently reduce weight bias among our future healthcare workforce.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that no AI or AI-assisted technologies have been used to generate, refine, or correct the content in the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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Contact email: lytvyak@ualberta.ca

Integrating Generative AI Into Construction Education: A Structured Classroom Activity for Reasoning, Reflection, and Responsible Use

Yajie Liu, Southern Utah University, United States
Minerva Bonilla, Texas A&M University, United States

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Abstract

As artificial intelligence (AI) continues to reshape professional practices across industries, higher education must prepare students to engage critically, creatively, and responsibly with these technologies to ensure future workforce readiness. While AI tools are becoming increasingly prevalent in construction practice, there is limited pedagogical research on how generative AI can be purposefully integrated into construction education to benefit both instructors and students. This paper aims to explore how generative AI tools—such as ChatGPT, Copilot, Gemini, and discipline-specific applications—can be integrated into construction education to enhance teaching effectiveness and improve student learning productivity and efficiency. The proposed instructional activity engages undergraduate construction students in both technical problem-solving and creative design tasks. Students first complete a task using only their own knowledge and course materials, then revisit the same task with three AI tools of their choice to generate alternative solutions, explanations, or design concepts. They conclude with a written reflection on how AI outputs influenced their reasoning, addressed misconceptions, improved efficiency, or provided new perspectives, and suggest additional ways AI could support construction-related learning. The activity's novelty lies in its multi-tool AI integration, structured reflection process, and comparative evaluation of human- versus AI-generated work. Although empirical results are not yet available, the paper will present the activity framework, sample prompts, and planned qualitative analysis methods. The expected outcome is a practical, adaptable model for embedding AI into construction education that advances responsible AI adoption and prepares future professionals for an AI-enabled industry.

Keywords: generative AI, construction education, AI literacy, reflective learning, problem-solving, design thinking

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Introduction

Recent evidence confirms that student adoption of generative artificial intelligence is both rapid and widespread. A 2025 survey by the Higher Education Policy Institute (2025) reports that more than 90 percent of undergraduate students now use generative AI tools, with the majority employing them for assessed coursework, including concept explanation, technical summarization, and text generation. While students report benefits related to productivity and learning support, many also express concerns regarding academic integrity, over-reliance, and uncertainty about appropriate use. Notably, the survey highlights a persistent gap between AI usage and institutional guidance, as relatively few students receive formal training in responsible or reflective AI use. These findings indicate that generative AI is already embedded in students' academic workflows, underscoring the urgency for structured pedagogical frameworks that support ethical, reflective, and discipline-appropriate integration rather than prohibition or ad hoc adoption.

Parallel to this trend in higher education, generative AI tools, particularly large language models such as ChatGPT, are being rapidly adopted across the construction industry for tasks including documentation drafting, estimating support, scheduling logic exploration, building information modeling rule checking, and technical communication. Construction and engineering students are therefore encountering AI not only as an academic aid but also as an emerging professional tool aligned with contemporary industry practice. However, the pace of adoption has outstripped the development of structured educational approaches that guide pedagogically sound, ethical, and reflective use of these technologies within construction education.

Construction-related disciplines, including surveying, building information modeling, estimating, and construction management, rely heavily on procedural reasoning, error analysis, and professional judgment. These competencies are foundational to safe and effective practice. Uncritical or unrestricted use of generative AI in these contexts risks undermining skill development by obscuring reasoning processes, masking errors, encouraging superficial understanding, and promoting excessive reliance on automated outputs. Conversely, outright prohibition of AI tools is increasingly impractical and misaligned with professional realities, as AI-enabled workflows are becoming common in construction practice.

As a result, instructors frequently face a binary and problematic choice: either banning AI entirely or allowing unrestricted use. Both approaches present clear limitations. Total prohibition is difficult to enforce and may ignore evolving industry expectations, while unrestricted use can erode learning outcomes, compromise academic integrity, and weaken students' capacity for independent reasoning. These challenges highlight the need for instructional approaches that move beyond enforcement or avoidance and instead emphasize intentional and pedagogically grounded integration.

When thoughtfully incorporated into coursework, generative AI has the potential to function as a reasoning aid rather than an answer-generating shortcut. A reflective integration approach can preserve human reasoning as the foundation of learning while leveraging AI as a comparative tool that exposes alternative solution strategies, underlying assumptions, and potential errors. Such an approach also supports the development of students' ability to critically evaluate AI-generated outputs, recognize their limitations, and apply ethical and professional judgment in AI-supported decision-making.

In response to these challenges, this paper presents a structured classroom activity framework for integrating generative AI into construction education. The framework emphasizes independent problem solving, systematic comparison between human and AI reasoning, and structured reflection on ethical and professional implications. Rather than positioning AI as a replacement for student thinking, the proposed approach treats AI as a comparative reasoning partner whose outputs must be scrutinized, validated, and contextualized by students.

The primary purpose of this study is to document and share a scalable and tool-independent instructional framework that supports responsible and reflective use of generative AI in construction education. Specifically, the objectives of this paper are to (1) design a three phase classroom activity that balances independent human problem solving with AI assisted reasoning, (2) apply the framework across multiple construction related courses, (3) develop an assessment strategy that evaluates both technical performance and reflective thinking, and (4) demonstrate how generative AI can enhance rather than replace student learning in surveying, building information modeling, and construction management contexts.

Related Work

The emergence of ChatGPT and other generative AI tools has prompted a growing body of research on their role in engineering and construction education. Studies have focused on student and faculty attitudes, classroom implementation, and overall learning impact.

Sajawal (2024) surveyed 269 engineering students on their beliefs about ChatGPT's future in education. While many anticipated positive advancements, concerns about academic integrity, skill erosion, and equitable access were prevalent. Students were divided on whether ChatGPT supports critical thinking, reflecting a complex blend of enthusiasm and skepticism.

Zhao et al. (2025) expanded this perspective by surveying both students and faculty after prolonged exposure to ChatGPT. Students, initially optimistic, became increasingly concerned about plagiarism and over-reliance. Faculty emphasized preserving critical thinking and writing skills. Both groups agreed on the need for clear policies and AI-literacy training. Zhao et al. recommend integrating process-focused assessments and responsible AI-use guidelines to uphold academic integrity while leveraging AI's benefits.

Buyones-Gonzalez (2025) explored ChatGPT integration in an applied statics course for construction engineering students. Over one semester, students reported that AI helped clarify concepts, improve structural reasoning, and encourage reflection. Ethical awareness also increased, particularly around citation and appropriate use. The study suggests that structured AI use can enhance engagement and critical thinking.

Sahraoui et al. (2025) piloted a generative AI workflow in a graduate-level BIM course. Students used an LLM to check Revit models for code compliance. While learning objectives were met, students faced challenges debugging AI-generated code, often due to limited programming skills. Despite increased cognitive load, learners expressed interest in further GenAI integration, underscoring the importance of scaffolding and technical support.

Wang and Fan (2025) conducted a meta-analysis of 51 studies on ChatGPT's educational impact. They found that AI use significantly improved learning performance (effect size $g \approx 0.87$, which is considered a large effect, with values above 0.8 generally viewed as strong, 0.5 as moderate, and 0.2 as small) and had moderate positive effects on perception and higher-

order thinking. These outcomes vary by course type, duration, and AI role. The authors recommend scaffolding ChatGPT use with frameworks like Bloom's taxonomy, integrating it into diverse teaching modes, and promoting sustained use over time. They also call for more research into AI's effects on critical thinking and student engagement.

Collectively, these studies show that generative AI, when thoughtfully integrated, can enhance engineering education through improved reasoning, reflection, and engagement. They also highlight the need for ethical safeguards, clear usage policies, and structured implementation to avoid skill erosion and misuse. These insights support the development of reflective, scaffolded AI-integration frameworks, like the one proposed in this paper, to prepare students for responsible AI use in engineering and construction practice.

Methodology

This section describes the implementation of a generative AI-integrated instructional framework across multiple construction-related courses. It presents the instructional context, the course domains selected for implementation, the structure of the learning activity, and the assessment approach used to evaluate student learning outcomes. The experimental setup was designed to examine how generative AI can be incorporated as a reflective reasoning support while maintaining the central role of human problem-solving and professional judgment.

Course Context and Selection

The instructional framework was implemented across undergraduate and graduate courses within a construction-focused engineering curriculum at two United States institutions. Courses were selected based on their strong emphasis on procedural reasoning, spatial modeling, and project planning. These domains require step-by-step logic, error identification, and judgment-based decision-making, making them well-suited for reflective integration of generative AI tools rather than direct answer generation. The following courses were selected for implementation.

Plane Surveying and GPS

In surveying courses, students engaged in applied tasks including closed traverse adjustment, differential leveling computations, coordinate geometry, and GPS error analysis. These activities require systematic calculation, careful attention to measurement precision, and explicit identification of error sources. Such characteristics make surveying coursework particularly appropriate for examining the role of generative AI in quantitative reasoning and error checking while preserving the importance of human judgment.

Revit-Based Architectural Design and Building Information Modeling

In Revit-based architectural design and building information modeling courses, instruction emphasized modeling strategy, system selection, and documentation logic rather than executing software commands. Students were required to justify modeling decisions such as wall system selection, family configuration, and system coordination. Generative AI tools were introduced to support exploration of alternative modeling workflows, enhance spatial reasoning, and surface assumptions embedded in design and documentation decisions.

Construction Management

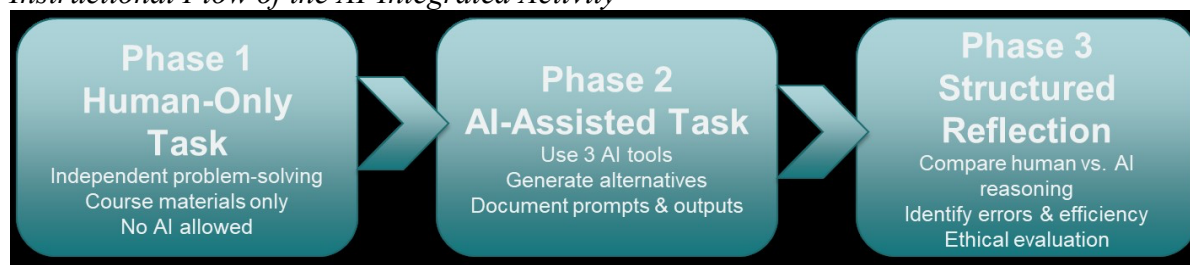
In construction management courses, students focus on estimating, scheduling, sequencing logic, and interpretation of construction documents. Course activities required students to generate and evaluate construction plans and schedules with an emphasis on feasibility, constructability, and consistency with professional standards. AI-generated schedules and cost estimates were compared with student-developed solutions to support evaluation of logic, decision quality, and alignment with industry expectations.

Instructional Framework and Procedure

Figure 1 illustrates the instructional flow of the AI-integrated activity implemented in this study. The activity was organized into three sequential phases that support progressive learning, beginning with independent human reasoning, followed by AI-supported comparison, and concluding with structured reflection.

Figure 1

Instructional Flow of the AI-Integrated Activity



Phase 1: Human-Only Problem Solving

In the first phase, students were required to solve assigned problems independently using standard course materials, lecture content, and their own domain knowledge. Use of generative AI tools was explicitly prohibited during this phase. The purpose was to ensure direct engagement with disciplinary concepts and to establish a baseline solution for subsequent comparison.

Representative tasks included closed traverse adjustment using field notes and computational formulas, selection of wall or roof systems based on project constraints, development of preliminary construction sequencing using Gantt charts, and completion of Revit modeling decisions for specified project scenarios. This phase reinforced technical competency, emphasized accountability, and preserved the central role of human reasoning in problem solving.

Phase 2: AI-Assisted Problem Exploration

After submitting their human-only solutions, students revisited the same problems using up to three generative AI tools such as ChatGPT, Bard, or Copilot. The intent of this phase was not to replace student solutions but to explore alternative reasoning strategies, identify assumptions, and examine how AI systems approach technical decision-making.

Students were required to document the exact prompts used with each AI tool, record the generated responses verbatim, and analyze the reasoning pathways suggested by the AI. They

also identified similarities and discrepancies between their own approaches and those produced by AI. Emphasis was placed on evaluating whether AI-generated outputs were logical, efficient, incomplete, or flawed, rather than on adopting them as final answers.

Phase 3: Structured Reflection and Evaluation

In the final phase, students engaged in structured reflection to critically evaluate both their human-generated solutions and AI-assisted outputs. Guided reflection prompts were used to support higher-order thinking and ethical awareness.

Students were asked to examine differences in reasoning and assumptions, assess whether AI identified errors or offered more efficient logic, evaluate risks or inaccuracies present in AI outputs, and consider contexts in which AI use would be appropriate in future professional practice. Through this reflective process, AI was positioned as a comparative reasoning companion rather than a solution provider.

Learning Objectives

The instructional framework was designed to achieve three primary learning objectives aligned with the evolving demands of construction education in an AI-enabled environment.

First, the activity strengthens independent problem-solving by requiring students to complete technical tasks without generative AI assistance. This reinforces foundational skills, supports mastery of discipline-specific knowledge, and maintains the integrity of core engineering competencies. Second, the framework develops students' ability to critically evaluate AI-generated outputs. By systematically comparing human and AI reasoning, students learn to assess accuracy, logic, and underlying assumptions, fostering analytical thinking and professional skepticism essential to construction practice.

Finally, the activity promotes responsible and ethical use of AI. Through structured reflection, students engage with issues related to academic integrity, AI limitations, and appropriate boundaries for AI assistance. This prepares students to navigate ethical decision-making in both academic settings and real-world construction environments. Collectively, these objectives support workforce readiness and reflect the growing role of AI in contemporary construction practice.

Assessment Strategy

A rubric-based grading scheme was developed to evaluate student performance across the three instructional phases. The rubric was applied consistently across participating courses and was designed to capture both technical proficiency and the depth of students' reflective engagement with generative AI tools. Assessment emphasized not only students' ability to solve engineering problems, but also their capacity to critically analyze and ethically evaluate the role of AI in professional tasks.

The first assessment component, Human Only Task Completion, accounted for 30 percent of the total grade. This component evaluated students' ability to independently solve assigned problems without AI assistance. Criteria included the correctness and completeness of solutions, clarity and coherence of reasoning, and adherence to course standards and accepted

disciplinary methods. This component ensured that students demonstrated mastery of core technical concepts and independent reasoning prior to AI engagement.

The second component, AI-Assisted Comparison and Analysis, also accounted for 30 percent of the total grade. This portion assessed students' ability to use generative AI tools to revisit the same problems in a critical and structured manner. Students were evaluated on the clarity and completeness of prompt documentation, accurate presentation of AI-generated outputs, and identification of meaningful differences between human and AI reasoning. Emphasis was placed on students' ability to interrogate AI logic, particularly when identifying efficiency gains, flawed assumptions, or alternative reasoning strategies introduced by the AI.

The third component, Structured Reflection and Critical Evaluation, accounted for the remaining 40 percent and placed the greatest emphasis on higher-order thinking. Reflection was assessed based on the depth of students' analysis, including recognition of AI limitations, reasoning errors, and uncertainty. Evaluation also considered students' ethical awareness, specifically their understanding of academic integrity, professional responsibility, and appropriate boundaries for AI use in engineering and construction contexts.

Together, these three components of the rubric were designed to promote AI literacy while reinforcing student ownership of the learning process. The assessment strategy balanced technical rigor with reflective and ethical considerations, supporting the preparation of future construction professionals for responsible engagement with emerging technologies.

Table 1

Rubric for Assessment of AI-Integrated Learning Activity

Performance Level	Description		
	Criterion 1: Human-Only Task Completion (30%)	Criterion 2: AI-Assisted Comparison and Analysis (30%)	Criterion 3: Structured Reflection and Critical Evaluation (40%)
Excellent (A)	Demonstrates clear, logical reasoning and appropriate application of course concepts. Solution or design decisions are well-justified, even if minor computational or modeling errors are present.	Effectively uses multiple AI tools and clearly documents prompts and outputs. Provides a thoughtful comparison between human and AI-generated solutions, identifying differences in assumptions, logic, and accuracy.	Demonstrates deep reflection on how AI influenced understanding, efficiency, and reasoning. Clearly identify AI limitations, misconceptions, and appropriate professional use cases. Shows strong ethical awareness.
Good (B)	Shows generally correct approach and understanding, with some gaps in explanation or minor conceptual errors. Reasoning is present but not fully articulated.	Use AI tools appropriately and document outputs. Comparison identifies some differences but lacks depth in evaluating reasoning or limitations.	Reflects on AI usefulness and limitations with reasonable insight. Ethical considerations are mentioned but not fully developed.

Satisfactory (C)	Attempts the task with partial understanding. Reasoning is incomplete or unclear, and errors indicate conceptual misunderstandings.	AI use is evident but poorly documented. Comparison is superficial, focusing mainly on results rather than reasoning.	Reflection is descriptive rather than analytical. Limited discussion of AI limitations or professional implications.
Unsatisfactory (D/F)	Minimal effort or incorrect approach. Lacks evidence of independent reasoning or meaningful engagement with course materials.	Inappropriate or undocumented AI use. Little to no meaningful comparison between human and AI work.	Reflection is minimal or missing. Shows little awareness of AI limitations, risks, or ethical considerations.

Discussion

The implementation of the AI-integrated instructional framework yielded several notable educational benefits across a range of construction-related courses. Although the study did not employ quantitative measures to assess learning gains, qualitative observations and instructor feedback collected across multiple semesters revealed consistent patterns that highlight the framework's pedagogical value and broader applicability.

One prominent outcome was improvement in students' AI literacy. Through structured and guided interaction with generative AI tools, students developed a more realistic understanding of both the capabilities and limitations of these technologies. Rather than viewing AI as an authoritative source of correct answers, students learned to recognize its strengths, such as efficiency, clarity of language, and synthesis of information, as well as its weaknesses, including logical gaps, overgeneralization, and limited sensitivity to context. This experiential engagement supported students' ability to distinguish between superficially correct outputs and sound reasoning, a critical competency in AI-mediated professional environments.

The framework also strengthened students' critical thinking and analytical skills. The structured comparison between human-generated and AI-assisted solutions required students to identify errors, evaluate assumptions, and justify preferred approaches. This process moved students beyond procedural execution toward deeper engagement with reasoning and decision making. As a result, the activity promoted reflective habits aligned with engineering judgment, particularly in situations involving uncertainty, incomplete information, or competing solution strategies.

Another important benefit was increased workforce readiness. By engaging with generative AI in the context of authentic construction tasks, including estimating, building information modeling, and surveying logic, students gained exposure to AI-supported workflows that are increasingly present in industry practice. Rather than framing AI as either a prohibited shortcut or an opaque tool, the framework positioned it as a professional resource that must be evaluated, validated, and used responsibly. This approach helped bridge the gap between academic preparation and the evolving expectations of the construction industry.

The instructional framework also demonstrated strong scalability and adaptability. Because the approach was tool-independent and did not rely on a specific software platform, it was successfully implemented across multiple courses and content areas. Instructors were able to

tailor the activity to different disciplinary contexts, ranging from spatial modeling to scheduling logic, and to accommodate varying levels of student familiarity with AI tools. This flexibility enhances the potential for broader adoption across construction and engineering education programs where reasoning and decision-making are central learning outcomes.

Collectively, these findings suggest several contributions to construction education. First, the framework provides a structured and ethical model for integrating generative AI into technical coursework, emphasizing reflection, responsibility, and critical evaluation rather than answer generation. Second, it demonstrates how systematic comparison between human and AI reasoning can deepen students' understanding of both disciplinary concepts and technological limitations. Third, the successful application of the framework across surveying, building information modeling, and construction management supports its relevance for cross-disciplinary curriculum development. Finally, the approach aligns construction education more closely with emerging industry practices, supporting students' transition into AI-enabled professional environments.

In summary, this work addresses a pressing challenge in engineering education, namely, how to integrate generative AI in ways that enhance learning without undermining foundational competencies. By centering independent reasoning, structured comparison, and ethical awareness, the proposed framework offers a practical pathway for preparing construction professionals who are capable of critical and responsible engagement with AI in future practice.

Conclusion and Future Work

As generative AI continues to shape the construction industry and engineering professions, higher education must evolve to prepare students for AI-integrated practice. Tools like ChatGPT are increasingly used in documentation, estimation, and planning, making it essential for educators to design frameworks that harness AI's benefits while safeguarding learning outcomes and ethical standards.

This paper introduced a structured, three-phase instructional framework that positions generative AI as a reasoning aid rather than a shortcut to answers. By engaging students in independent problem-solving, AI-assisted analysis, and structured reflection, the framework promotes AI literacy, critical thinking, and responsible use. Its adaptability across construction disciplines—such as surveying, BIM, and project management—demonstrates its scalability and relevance to real-world professional demands.

While the initial implementation revealed clear educational benefits, further research is needed to assess long-term impacts. Future work will include formal evaluation of learning outcomes, studies on skill retention, and broader application across engineering domains. By embedding AI thoughtfully into instruction, educators can better prepare students for ethical, reflective engagement with the technologies shaping their future workplaces.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that ChatGPT, an AI-assisted writing software, was used in proofreading and refining the language used in the manuscript. The usage was limited to correcting grammatical and spelling errors and rephrasing statements for accuracy and clarity. The author further declares that, apart from Grammarly, no other AI or AI-assisted technologies have been

used to generate content in writing the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from appropriate and systematic conduct of the research.

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Perceptions of the Metaverse in Education: An Exploratory Qualitative Study on Creative Destruction From the Perspective of Generation Z

Mathis Kleffner, FOM University of Applied Sciences, Germany
Katerina Schmitz-Jakovou, Universidad CEU San Pablo, Spain
Alexander Zureck, FOM University of Applied Sciences, Germany

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Abstract

The metaverse is often described as the next evolutionary stage of the internet, enabling immersive, interactive, and persistent three-dimensional environments (Kreutzer & Klose, 2023). Such developments raise questions as to whether metaverse-related educational offerings could disrupt traditional learning formats, potentially constituting “creative destruction” in Schumpeter’s sense (Schumpeter, 1942). This study explores how members of Generation Z perceive immersive learning experiences after testing a set of XR applications (language learning, music learning, 3D design, mathematics, and fitness) on a stand-alone headset. Using a qualitative, exploratory research design, four problem-centred, semi-structured interviews were conducted (Witzel & Reiter, 2012) and analysed using qualitative content analysis (Kuckartz & Rädiker, 2023). The findings indicate broadly positive evaluations of immersion, interactivity, and self-paced learning. At the same time, participants highlighted barriers such as cost, limited institutional implementation, usability frictions, and uncertain societal adoption. Regarding creative destruction, respondents tended to view immersive offerings as complementary rather than fully substitutive at present. However, they anticipated that future hardware developments could increase adoption and, in specific domains, lead to greater displacement potential (Meta, 2024). Overall, metaverse-related learning is perceived as promising but not yet disruptive enough to constitute creative destruction in education under current conditions.

Keywords: metaverse, educational innovation, Generation Z, creative destruction, immersive technologies

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Introduction

Immersive technologies and the broader “metaverse” discourse are reshaping expectations surrounding digital interaction and learning. The metaverse is commonly framed as a persistent, real-time, and interconnected network of three-dimensional virtual environments that enables social interaction as well as novel forms of experience and participation (Kreutzer & Klose, 2023). In educational contexts, this vision translates into opportunities for experiential learning, simulation, embodiment, and interactive practice. Such benefits may resonate particularly strongly with Generation Z as a digitally socialised cohort (Camilleri, 2024).

At the same time, it remains unclear whether learners, especially members of Generation Z, already perceive metaverse-related learning as sufficiently mature, accessible, and institutionally integrated to challenge established educational formats. This question becomes especially relevant when educational innovation is interpreted through Schumpeter’s concept of creative destruction, according to which new innovations may replace existing structures and routines (Schumpeter, 1942).

Against this background, this paper addresses the following research question: To what extent does Generation Z perceive metaverse-related immersive educational offerings as (potential) “creative destruction” in Schumpeter’s sense?

To provide empirically grounded insights, this study combines hands-on testing of XR learning applications with qualitative interviews focusing on perceived learning value, barriers, and displacement potential.

Theoretical Background

Metaverse and Education

In recent literature, the metaverse is described as an interoperable, decentralised, and persistent network of real-time generated three-dimensional environments. Core characteristics frequently include immersion, synchronicity, persistence, interoperability, and social interaction (Kreutzer & Klose, 2023). In educational contexts, metaverse-related environments promise more than mere content delivery, as they potentially support situated learning, embodied interaction, collaboration, and simulation-based training (Camilleri, 2024; McKinsey & Company, 2022).

Not all XR learning applications constitute a “metaverse” in the strict sense, for example persistent shared worlds with interoperability. In practice, however, many educational discussions treat immersive XR learning as metaverse-related because it relies on the same enabling technologies, including XR, spatial computing, and real-time 3D rendering (McKinsey & Company, 2022). This paper therefore uses the term metaverse-related immersive learning as an umbrella concept, while explicitly acknowledging its conceptual limitations in Section 7 (Limitations).

Extended Reality (XR): VR, AR, and MR

Extended Reality (XR) is a collective term for immersive technologies that blend physical and virtual elements. Virtual Reality (VR) is typically defined as a fully computer-generated environment in which the physical world is largely blocked out, enabling users to interact

within a simulated world. Augmented Reality (AR) overlays digital elements onto the real world, while Mixed Reality (MR) anchors virtual objects spatially within the user's physical environment (Umweltbundesamt, 2021).

Generation Z and Learning Preferences

Generation Z is generally characterised as highly digitally connected and accustomed to video-based, interactive, and mobile-first information practices. For instance, a Bitkom study reports that 93 percent of children and adolescents aged 10 and above use social networks, highlighting the central role of digital platforms in everyday life (Bitkom, 2024).

With regard to learning, research suggests that many members of Generation Z report preferences for multimodal and interactive forms of input. In a study using the VARK questionnaire, Gen Z undergraduates demonstrated a strong preference for multimodal learning (Ishak et al., 2022). While learning style frameworks should be interpreted with caution, such findings are consistent with the assumption that interactive and multi-sensory environments may be perceived as motivating by this cohort.

Schumpeter's Creative Destruction in Education

Schumpeter conceptualises innovation as a process that can disrupt and replace existing structures through what he terms creative destruction, driven by new products, processes, markets, resources, or organisational forms (Schumpeter, 1942). When applied to education, the central question is whether immersive learning technologies merely enhance existing formats as complementary innovations or replace substantial elements of teaching practices and institutional routines through disruptive substitution. A key condition for creative destruction is therefore not only technical feasibility, but also adoption, diffusion, and institutional embedding (Schumpeter, 1942).

Methodology

Research Design

This study employs a qualitative, exploratory research design to capture subjective evaluations and meaning-making processes. Qualitative approaches are particularly suitable for investigating emerging phenomena and are appropriate when the primary objective is depth of understanding rather than statistical generalisation.

Sample and Procedure

Four participants belonging to Generation Z were recruited through purposive sampling to ensure heterogeneity in educational and professional backgrounds. Participants tested five XR applications (Noun Town, PianoVision, Gravity Sketch, Math World VR, and Les Mills Bodycombat) using a stand-alone XR headset capable of VR and MR experiences.

Following a guided familiarisation phase, each application was used during a short trial session of approximately 15 minutes. Subsequently, participants took part in a problem-centred, semi-structured interview (Witzel & Reiter, 2012). All interviews were audio recorded, transcribed verbatim, and anonymised.

Interview Guide

The interview guide combined experiential prompts, such as first contact with the headset and interface, with application-level evaluations and progressively broader reflections on education and disruption. The interview structure moved from specific applications toward the overarching thematic framework. This approach enabled interviewees to systematically develop and articulate their own perspectives while providing guiding reference points throughout the interview.

The interviews were conducted in a semi-structured format. Due to their open-ended nature, this approach allowed for a comprehensive exploration of the interviewees' perspectives and facilitated an in-depth understanding of the underlying factors and experiences shaping these views.

Data Analysis

Data were analysed using qualitative content analysis, combining deductive and inductive category development (Kuckartz & Rädiker, 2023). Deductive main categories were derived from the research question and interview guide:

1. first impressions of XR technology,
2. application-related benefits and limitations, and
3. metaverse-related education and disruption potential.

Within category (2), application-specific subcategories were developed inductively. Within category (3), inductive subcategories captured themes such as perceived displacement potential, prerequisites for disruption, and future outlook.

Results

Immersion and “Being There” as Added Value

All participants identified immersion and a sense of presence as key differentiators compared to conventional digital learning formats. The experience was described as participatory rather than consumptive, supporting active engagement with learning content.

Interactivity, Control, and Self-Paced Learning

Participants valued interactive control, including object manipulation and immediate feedback, as well as the ability to progress at an individual pace. These features were perceived as aligned with personal learning preferences and as potentially supportive of multimodal engagement (Ishak et al., 2022). Language- and music-related applications were most frequently described as intuitive and motivating, as learning progress felt tangible and feedback immediate.

Barriers: Access, Cost, Usability, and Institutional Reality

Despite generally positive attitudes, participants reported substantial barriers, including limited access to XR hardware, high costs, insufficient institutional readiness, and usability or comfort-related issues.

Complement Rather Than Replacement

When reflecting on the potential displacement of traditional education, participants predominantly expressed a view of complementarity. Immersive learning was perceived as capable of enriching specific learning contexts, but not of replacing education as a whole in the near term.

Conditions Under Which Creative Destruction Becomes Plausible

Assessments shifted when participants discussed future technological developments. Several interviewees suggested that more discreet, glasses-like AR form factors could increase social acceptance and everyday integration. Current industry developments in this direction are illustrated by Meta's presentation of "Orion" as a prototype AR glasses system (Meta, 2024). Under conditions of lower costs, improved comfort, and stronger institutional embedding, participants considered a higher displacement potential plausible in selected educational domains.

Discussion

The findings suggest that Generation Z perceives metaverse-related immersive learning as meaningful and motivating, primarily due to immersion, interactivity, and self-paced engagement (Camilleri, 2024). From a Schumpeterian perspective, however, the innovation currently appears more complementary than structurally disruptive for education. Participants' emphasis on costs, limited institutional adoption, and usability challenges indicates that diffusion and institutional embedding remain insufficient for systemic replacement (Schumpeter, 1942).

At the same time, perceived disruptiveness appears conditional. As hardware evolves toward more socially acceptable form factors and institutions develop appropriate infrastructure and pedagogical integration, displacement potential may increase (McKinsey & Company, 2022; Meta, 2024). Metaverse-related education may therefore be situated in an early diffusion phase in which benefits are visible, but large-scale structural change remains unlikely at present.

Conclusion

Participants from Generation Z evaluated immersive XR learning applications positively, emphasising immersion, interactivity, and flexible self-paced learning. At present, these offerings are primarily perceived as complements to traditional educational formats rather than replacements and therefore do not yet constitute full creative destruction in Schumpeter's sense (Schumpeter, 1942). Disruptive potential appears contingent on improved accessibility, stronger institutional integration, and continued technological progress, particularly regarding more wearable AR form factors (Meta, 2024). For education providers and policymakers, this suggests a focus on targeted use cases where XR adds clear value, alongside investments in implementation infrastructure and equity considerations related to access and cost.

Limitations

This exploratory study is subject to several limitations:

1. the small qualitative sample size ($n = 4$), which restricts generalisability;

2. the short trial duration per application, limiting conclusions regarding long-term learning outcomes; and
3. the conceptual gap between the metaverse as an interoperable and persistent environment and the tested XR applications, which do not necessarily constitute metaverse platforms in a strict sense.

Additionally, methodological triangulation, such as surveys, observations, or learning performance measures, was not employed and should be addressed in future research.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

Generative AI and AI-assisted technologies were used in a supportive capacity during the writing process of this manuscript. Specifically, an AI-based language model (ChatGPT by OpenAI) was employed for language editing, proofreading, and stylistic refinement. The AI tool was used exclusively to improve clarity, grammar, and academic expression. All substantive content, interpretations, and conclusions were developed by the authors, who take full responsibility for the integrity and originality of the work.

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Contact emails: alexander.zureck@fom-net.de
 katerina.mariaschmitzjakovou@us
 mat.kleffner@gmail.com

Information Skills of University Freshmen and General Informatics Education

Tomohiro Inagaki, Hiroshima University, Japan
Naohiro Chubachi, Takasaki University of Commerce, Japan
Kazuki Kawamura, Tokyo International University, Japan
Yuko Murakami, Hiroshima University, Japan

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Abstract

In Japan, the introduction of “Information I” into the Common Test for University Admissions in 2025, together with its adoption by many universities, marked a major shift in informatics education. This development followed the establishment of “Information I” as a compulsory subject in high school curricula under the revised Course of Study, implemented from the 2022 academic year. This systemic change is expected to reshape the information skills of incoming freshmen and necessitates an evidence-based redesign of general informatics education at universities. Using longitudinal results from the Information Placement Test (IPT) administered at Hiroshima University between 2022 and 2025, together with student-level response data from 2023, this study analyzes trends in correct, incorrect, and unknown responses. We demonstrate that a sharp improvement occurred between 2024 and 2025, accompanied by extremely large effect sizes (Cohen’s h). Student-level analyses further reveal that uncertainty (“unknown” responses) constitutes a distinct and more severe learning state than incorrect answers. Across all content areas, learning gains are driven primarily by reductions in uncertainty rather than by decreases in incorrect answers. These findings underscore the central role of uncertainty reduction in the post-2025 context of general informatics education.

Keywords: information placement test, general informatics education, unknown responses

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Introduction

Information skills are essential competencies for all university freshmen in today's advanced information society. In Japan, general informatics education is often positioned within liberal arts curricula and is provided to all students regardless of major. Some universities have introduced placement tests to assess incoming students' readiness; however, these tests are used primarily for course assignment, with limited analytical application beyond basic accuracy rates (Chubachi, 2022; Inagaki & Murakami, 2023; Kawamura, 2019; Tokuno, 2024).

In 2025, Japan experienced a major policy shift: "Information I" was introduced into the Common Test for University Admissions and adopted by many universities (See for example, Nakano, 2026). This change formalized the assessment of information skills prior to university entry and is expected to substantially alter the academic preparedness of incoming freshmen. Under these new educational conditions, universities urgently require an evidence-based understanding of how freshmen's information skills are evolving and how general informatics education should respond. A longitudinal analysis of placement test data provides a unique opportunity to examine whether, and in what ways, this policy change is reflected in students' information skills.

This study addresses this need by analyzing longitudinal placement test data collected during the transition period (2022–2025) and by focusing on an often-overlooked response category: "I don't know" (unknown). We argue that uncertainty, as captured by unknown responses, represents a distinct cognitive state with important educational implications. Specifically, we demonstrate that learning gains are driven not only by reductions in incorrect answers but, more importantly, by decreases in uncertainty across content areas. Building on this context, this study addresses the following research questions:

1. How have university freshmen's information skills evolved from 2022 to 2025?
2. What role does uncertainty, as captured by unknown responses, play in learning gains?
3. What implications do these changes have for general informatics education in the post-2025 era?

Methods

This section describes the assessment instrument, participants, and analytical procedures used to examine longitudinal changes in freshmen's information skills during the 2022–2025 transition period. Particular emphasis is placed on the role of uncertainty, captured through explicit unknown ("I don't know") responses, as a key dimension of students' preparedness for general informatics education.

Instrument: Information Placement Test (IPT)

The Information Placement Test (IPT) is a standardized assessment developed by the Committee on General Informatics Education of the Information Processing Society of Japan. Its purpose is to assess students' readiness for general informatics education, rather than to select or exclude students.

The IPT is based on the General Education Body of Knowledge (GEBOK) framework and covers ten content areas spanning technical, conceptual, and societal dimensions of informatics (IPSJ, 2018). Eight of these correspond to the GEBOK core domains: Information and Communication, Digitization of Information, Fundamentals of Computing Systems, Data

Models and Databases, Information Networks, Information Systems and Society, Information Security and Ethics, and Academic ICT Literacy. The remaining two areas were added based on the Japanese high school curriculum guidelines and textbooks: Problem Solving and Algorithms and History and Future of Media and Computing.

The IPT consists of 51 multiple-choice questions selected from a standardized database of 188 items, including one basic check item. Each question provides four answer options and an explicit “I don’t know” (unknown) option. Responses were classified into three categories: correct, incorrect, or unknown.

The present study analyzes aggregated IPT results from 2022 to 2025, as well as student-level response data from 2023. Longitudinal trends were examined at the content-area level, and paired statistical tests with effect sizes were used to evaluate changes between 2024 and 2025. Student-level analyses were further conducted to identify learner profiles and to compare unknown-rich and incorrect-rich groups.

Participants and Procedure

The participants were first-year undergraduate students at Hiroshima University enrolled in the general informatics course Introduction to Information and Data Science, which is offered as part of the university’s liberal arts curriculum. The IPT was administered during the first class meeting each academic year in order to assess students’ readiness for general informatics education upon university entry. In 2022 and 2023, a fixed test form was administered, whereas in 2024 and 2025, items were randomly drawn from the item pool. Students completed the IPT within approximately 20 minutes of scheduled class time, followed by an additional 15-minute break period. The test was conducted in a standardized format across all years of data collection.

The number of valid responses was 1,736 in 2022, 1,723 in 2023, 2,167 in 2024, and 2,381 in 2025. These samples represent more than 80% of the incoming freshman cohort each year, ensuring broad coverage of the first-year student population and enabling robust longitudinal comparisons.

Ethical considerations were addressed by analyzing only anonymized assessment data collected as part of regular educational activities. Participation had no effect on course grading, and all results were reported in aggregate form to ensure confidentiality. This design allows placement-test data to be used not only for course assignment but also as evidence for curriculum redesign in the post-2025 era.

Data Analysis

IPT responses were analyzed at both the aggregated and student levels to examine longitudinal changes in freshmen’s information skills and the educational role of uncertainty. Each response was classified into one of three categories: correct, incorrect, or unknown (“I don’t know”). For each year from 2022 to 2025, the proportions of these response categories were calculated overall and separately for each of the ten IPT content areas.

To investigate changes associated with the policy transition period, analyses focused on differences between 2024 and 2025. Two-proportion *z*-tests were performed at the item level to compare response-category proportions between the two cohorts. Effect sizes for these

proportion differences were quantified using Cohen's h , which is appropriate for evaluating changes in response rates. Content-area patterns were then examined by summarizing item-level effect sizes within each domain, providing descriptive indicators of the magnitude and consistency of changes across items.

The IPT was administered using a fixed test form in 2022 and 2023, whereas in 2024 and 2025 items were randomly drawn from the standardized question pool. To ensure comparability across years, all analyses for 2024 and 2025 were restricted to the subset of items that were identical to those used in 2022 and 2023, whereas the full fixed-form datasets were analyzed for 2022 and 2023. This approach enabled consistent longitudinal comparisons despite changes in item administration.

In addition, student-level response data from 2023 were used to explore heterogeneity in learner profiles. Students were grouped according to their relative proportions of unknown and incorrect responses, allowing the identification of unknown-rich and incorrect-rich response patterns. Comparative analyses were performed to examine how these profiles differed across content areas and to clarify the distinct educational implications of uncertainty versus incorrect knowledge.

All statistical analyses followed standard procedures, and results are reported with corresponding significance levels and effect-size measures. The basic check item was excluded from the analyses.

Results

This section presents the longitudinal results of the IPT from 2022 to 2025, with particular attention to changes observed during the policy transition in 2025. In addition to overall performance trends, we highlight the central role of uncertainty reduction, reflected in decreases in unknown responses, as a major driver of learning gains.

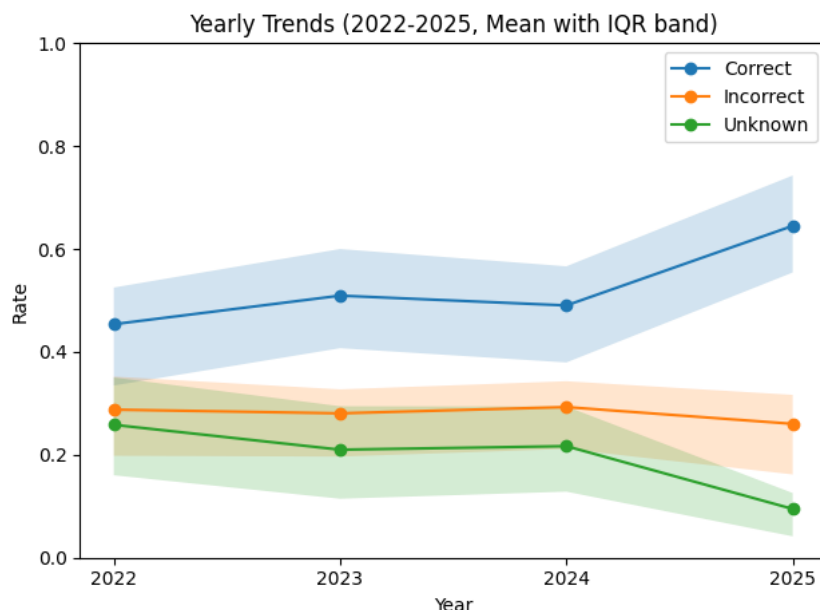
Overall Trends in Response Categories

Figure 1 presents the overall longitudinal trends in freshmen's IPT response patterns from 2022 to 2025, showing the proportions of correct, incorrect, and unknown ("I don't know") responses. Overall performance improved across the four-year period; however, changes were not uniform. In particular, response distributions remained largely stable between 2023 and 2024, with little evidence of substantial improvement during this interval.

In contrast, the most pronounced shift occurred between 2024 and 2025, coinciding with the introduction of "Information I" into the Common Test for University Admissions. This transition was characterized by an increase in correct responses accompanied by a marked reduction in unknown responses, suggesting that learning gains in the post-2025 cohort were driven primarily by decreased uncertainty rather than by simple reductions in incorrect answers.

Figure 1

Yearly Trends in IPT Response Categories (Correct, Incorrect, and Unknown) Among Hiroshima University Freshmen From 2022 to 2025, Based on Common Subset of Items



Content-Area Improvements

To quantify these changes at the domain level, Table 1 summarizes content-area differences in correct response rates between 2024 and 2025. Improvements were observed across all ten areas, with medium effect sizes in several foundational domains. The largest gains in correct responses were found in “Digitization of Information” ($\Delta\text{Correct} = +0.198$, Cohen’s $h = 0.45$) and “Information Systems and Society” ($\Delta\text{Correct} = +0.204$, Cohen’s $h = 0.44$), highlighting substantial strengthening of core informatics competencies.

Table 1

Content-Area Changes in Correct Response Rates Between 2024 and 2025

Content Area	Correct 2024	Correct 2025	$\Delta\text{Correct}$	Cohen’s h
Information and Communication	0.611	0.715	0.104	0.24
Digitization of Information	0.598	0.796	0.198	0.45
Fundamentals of Computing Systems	0.421	0.570	0.149	0.31
Data Models and Databases	0.444	0.604	0.160	0.32
Information Networks	0.485	0.638	0.153	0.31
Information Systems and Society	0.547	0.751	0.204	0.44
Information Security and Ethics	0.410	0.603	0.193	0.41
Academic ICT Literacy	0.462	0.593	0.132	0.28
Problem Solving and Algorithms	0.657	0.795	0.137	0.31
History and Future of Media and Computing	0.324	0.467	0.143	0.30

Note. Correct response rates are based on the common subset of IPT items administered across all years. Two-proportion z-tests were performed at the item level to compare the 2024 and 2025 freshman cohorts. Content-area results are reported as domain-level summaries of item-level outcomes, including changes in correct response proportions ($\Delta\text{Correct}$) and mean effect sizes (Cohen’s h). Cohen’s h represents the magnitude of proportion differences, with values around 0.20, 0.50, and 0.80 typically interpreted as small, medium, and large effects, respectively.

Given the particularly strong improvement in Digitization of Information, Figure 2 focuses on this domain as a representative example. As shown in Figure 2, performance in this area remained largely stable between 2023 and 2024, but exhibited a sharp increase in correct responses between 2024 and 2025. This shift was accompanied by a pronounced decline in unknown responses, indicating a major reduction in uncertainty in one of the most fundamental content areas related to binary representation, data units, and the principles of digital information.

Figure 2

Yearly Trends in Response Categories (Correct, Incorrect, and Unknown) in the Digitization of Information Content Area From 2022 to 2025

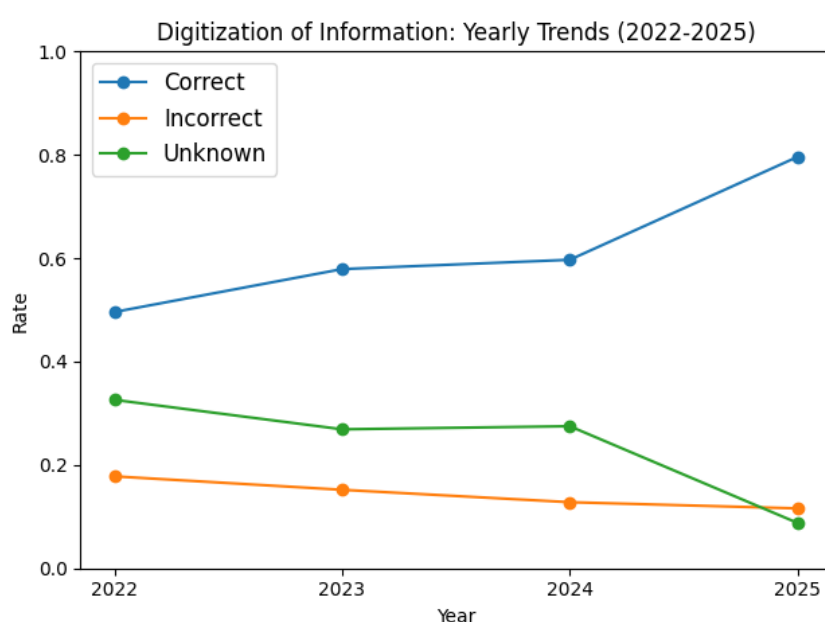


Table 2

Content-Area Changes in Unknown Response Rates Between 2024 and 2025

Content Area	Unknown 2024	Unknown 2025	Δ Unknown	Cohen's h
Information and Communication	0.216	0.131	-0.085	-0.22
Digitization of Information	0.275	0.088	-0.187	-0.52
Fundamentals of Computing Systems	0.307	0.127	-0.180	-0.45
Data Models and Databases	0.316	0.149	-0.168	-0.41
Information Networks	0.243	0.094	-0.149	-0.41
Information Systems and Society	0.231	0.073	-0.158	-0.46
Information Security and Ethics	0.321	0.187	-0.134	-0.32
Academic ICT Literacy	0.249	0.154	-0.095	-0.23
Problem Solving and Algorithms	0.198	0.091	-0.107	-0.27
History and Future of Media and Computing	0.332	0.204	-0.128	-0.30

Note. Unknown responses correspond to the explicit “I don’t know” option in the IPT. Rates are based on the common subset of IPT items administered across all years. Two-proportion z -tests were conducted at the item level to compare unknown-response proportions between the 2024 and 2025 cohorts. Content-area values represent domain-level summaries of item-level results, including changes in unknown response proportions (Δ Unknown) and mean effect sizes (Cohen’s h). Negative values of Cohen’s h indicate decreases in unknown responses, reflecting reductions in uncertainty. Values of $|h|$ around 0.20, 0.50, and 0.80 are typically interpreted as small, medium, and large effects.

Table 2 further demonstrates that reductions in unknown responses were consistently observed across all content areas. The largest decrease in uncertainty was again found in “Digitization of Information” ($\Delta\text{Unknown} = -0.187$, Cohen’s $h = -0.52$), followed by “Fundamentals of Computing Systems” ($\Delta\text{Unknown} = -0.180$, Cohen’s $h = -0.45$). These findings support the central argument of this study: that the most significant learning gains associated with the post-2025 transition are reflected not only in increased accuracy, but more importantly in substantial reductions in student uncertainty.

Together, Figures 1–2 and Tables 1–2 indicate that the 2025 policy shift was associated with a clear improvement in freshmen’s information skills, with domain-specific gains driven largely by decreased unknown responses. The following section further explores learner-level heterogeneity through unknown-rich and incorrect-rich response profiles.

Learner Profiles: Unknown-Rich Versus Incorrect-Rich Groups

To further examine learner-level heterogeneity underlying the aggregated trends, we analyzed student-level response patterns using the 2023 dataset. Students were classified into two contrasting profiles based on their proportions of unknown and incorrect responses. The unknown-rich group was defined as students with an unknown response rate of at least 0.40 (Unknown Rate ≥ 0.40 ; $N = 323$), representing learners with high levels of uncertainty. The incorrect-rich group was defined as students with a incorrect response rate of at least 0.40 combined with a low unknown rate (Incorrect Rate ≥ 0.40 and Unknown Rate ≤ 0.20 ; $N = 286$), representing learners who tended to provide incorrect answers rather than selecting “I don’t know.”

These two profiles exhibited markedly different overall performance levels. The unknown-rich group showed a substantially lower mean correct rate, 0.280, and a high mean unknown rate, 0.569, whereas the incorrect-rich group demonstrated a higher mean correct rate, 0.451, and a very low mean unknown rate, 0.041, accompanied by a high incorrect rate, 0.508. A Welch’s t -test confirmed that the difference in correct response rates between the two groups was extremely large and statistically significant, $t = -21.57$, $p < .001$.

Table 3

Content-Area Correct Response Rates for Unknown-Rich and Incorrect-Rich Student Profiles in 2023

Content Area	Unknown-rich	Incorrect-rich
Information and Communication	0.360	0.536
Digitization of Information	0.191	0.427
Fundamentals of Computing Systems	0.134	0.427
Data Models and Databases	0.141	0.476
Information Networks	0.240	0.492
Information Systems and Society	0.301	0.505
Information Security and Ethics	0.274	0.451
Academic ICT Literacy	0.276	0.420
Problem Solving and Algorithms	0.533	0.633
History and Future of Media and Computing	0.108	0.304

Note. Values indicate mean correct response proportions within each IPT content area. The unknown-rich group was defined as students with Unknown Rate ≥ 0.40 ($N = 323$), whereas the incorrect-rich group was defined as students with Incorrect Rate ≥ 0.40 and Unknown Rate ≤ 0.20 ($N = 286$).

Table 3 further represents how these profile differences vary across content areas by comparing domain-level correct response rates. Across nearly all areas, the incorrect-rich group consistently achieved higher correct rates than the unknown-rich group, indicating that incorrect-rich students often possess partial knowledge or misconceptions, whereas unknown-rich students exhibit substantially lower mastery accompanied by pronounced uncertainty. Particularly large gaps were observed in foundational domains such as Digitization of Information, Fundamentals of Computing Systems, and Data Models and Databases, highlighting areas where uncertainty may reflect deeper deficits in preparedness.

Together, these findings reinforce the central argument of this study: uncertainty, captured through explicit unknown responses, represents a distinct and educationally meaningful dimension of freshmen's information skills. Distinguishing between uncertainty-rich and error-rich learners may therefore be critical for designing effective post-2025 general informatics education.

Discussion

The present study provides clear evidence that university freshmen's information skills improved markedly during the 2022–2025 transition period, with the most pronounced shift occurring between 2024 and 2025 following the introduction of “Information I” into the Common Test. Importantly, these gains were characterized not only by increased accuracy but, more fundamentally, by substantial reductions in unknown responses across content areas. This pattern highlights uncertainty reduction as a central mechanism of learning progress in the post-2025 era.

Moreover, the learner-profile analysis demonstrated that uncertainty represents a distinct educational state rather than simply another form of error. Unknown-rich students exhibited significantly lower mastery than incorrect-rich students, suggesting that general informatics education must differentiate between learners who are uncertain and those who are confidently incorrect.

Conclusion

This study examined longitudinal changes in university freshmen's information skills during the 2022–2025 transition period using Information Placement Test (IPT) data collected at Hiroshima University. The results revealed that improvements were not gradual across all years but showed a pronounced shift between 2024 and 2025, coinciding with the introduction of “Information I” into the National Common Test for University Admissions.

A key finding is that these learning gains were driven primarily by substantial reductions in unknown (“I don't know”) responses, rather than by decreases in incorrect answers alone. This highlights uncertainty reduction as a central dimension of student preparedness in the post-2025 era. Student-level analyses further demonstrated that unknown-rich learners exhibit significantly lower mastery than incorrect-rich learners, indicating that uncertainty represents a distinct educational state rather than simply another form of error.

These findings carry important implications for general informatics education. Universities should explicitly address uncertainty in addition to correctness and differentiate instructional strategies for diverse learner profiles: unknown-rich students may require conceptual scaffolding and confidence-building support, whereas incorrect-rich students may benefit from

targeted misconception correction. Placement assessments such as the IPT can therefore serve not only for course assignment but also as evidence for curriculum redesign under the new educational conditions after 2025.

Several limitations should be noted. This study was conducted at a single institution, and broader validation across universities is needed. In addition, cohort differences may reflect factors beyond the policy change alone. Future work should extend multi-institutional analyses and evaluate instructional interventions aimed at reducing uncertainty and strengthening foundational competencies.

Overall, the introduction of “Information I” marks a new phase for university informatics education in Japan, and evidence-based approaches will be essential for supporting incoming students in the post-2025 era.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The authors declare that ChatGPT (OpenAI), an AI-assisted writing tool, was used to support proofreading and language refinement in this manuscript. Its use was limited to correcting grammatical and spelling errors and to minor rephrasing for clarity and accuracy. The authors take full responsibility for the content of the manuscript.

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Contact email: inagaki@hiroshima-u.ac.jp

Scientific Literacy as Part of the Science-for-All Movement

Emilio Landolfi, University of the Fraser Valley, Canada

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Abstract

This conceptual (theoretical) paper will focus on scientific literacy as part of the “science for all movement” through a historical examination of relevant scholarly material. The work reviews how the curriculum has often catered only to those hoping to pursue careers in science and how a significant group of the population remain incapable of making educated, informed choices on science-related issues as well as how these issues impact their everyday lives. A historical examination of illiteracy in science (for example, the opposition to important products and technologies such as vaccines) will be provided, along with how the “science for all” movement has attempted to respond to the need for increasing scientific literacy amongst the masses—examples of which include the American Association for the Advancement of Science’s Project to promote scientific literacy, and the National Science Foundation’s programs to diversify Science. The work will then explore how the “science for all” movement makes explicit connections to curriculum studies theories by examining how both positions (science for all and curriculum studies) stress the importance of becoming more critical, extending students’ range of perceptions, and broadening students’ perspective of the world around them while emphasizing practical implications for education (teachers, curricula, policy), thus making a unique contribution to the debate on scientific literacy relative to prior discussions on these significant issues.

Keywords: scientific literacy, science for all, science education, critical thinking, curriculum studies

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Introduction

An overwhelming majority of today's adult population have little or no knowledge of how science impacts their daily lives (Kazempour, 2014). Citizens are exposed to rapid advances in science and technology. Yet so many people are often left feeling afraid or intimidated by the very innovations which have been designed to simplify their existence.

Science literacy, as defined by the Organization for Economic Co-operation and Development [OECD], requires knowledge of key science concepts and the understanding of science processes which facilitates one's ability to make informed decisions on science-related issues which impact their lives (OECD, 2017). Glick et al. (2021) assert that the problem of scientific illiteracy stems mainly from a general fear of science which can usually be traced back to a person's negative experiences with science in school. Consequently, North Americans have a long history of illiteracy in science, and the problem is too widespread and too significant to be ignored (Tytler, 2014).

In addressing the issue of scientific illiteracy, the "Science for All" movement aims to ensure equality of educational opportunity through the provision of meaningful experiences in science for all students (Kembara et al., 2020). By "Science for All," I am referring to the movement aimed at making science more accessible, particularly to groups that have traditionally shunned science, hoping to increase scientific literacy amongst the general population (Mutegi, 2011). Interestingly, the introduction of the sciences into educational institutions of "all grades" has its roots in eighteenth century Germany while the United States began emphasizing science in schools during the first half of the nineteenth century in all secondary (high school) institutions (Graves, 1916).

This paper will focus primarily on scientific literacy as part of the North American "Science for All" movement while demonstrating how scientific literacy relates to the larger field identified by the term "curriculum studies." I will begin with a historical examination of illiteracy in science as it relates to traditional approaches to science education and how the "Science for All" movement has attempted to respond to the need for increasing scientific literacy amongst the masses. Furthermore, I will explore how the "Science for All" movement relates to the larger field of curriculum studies by examining how both positions emphasize becoming more analytical, extending students' range of perceptions, and broadening students' perspective of the world around them.

The Notion of Scientific Literacy

Science education in Westernized nations conventionally aimed at producing highly qualified scientists (Hetherington et al., 2020). Consequently, school science evolved into a minority pursuit for those few students who are most likely to study science at the post-secondary level and take up careers as specialized technologists or research scientists (Reinhold et al., 2018). Science has become a gatekeeper, an elitist subject that is often used to restrict access to many remunerative vocations in professional fields (Kelly et al., 2020).

H.E. Roscoe, the first President of the Association for Public School Science Masters, believed that school science was to be a method by which those who possessed the highest levels of competence and intelligence were to be sifted out from the significant populace of mediocrity (Sharp, 2017). Science as a means of understanding practical applications in everyday life had

disappeared from the curriculum by the 1870s, as school science gradually adopted a mission of producing the “pure” researcher (Singer et al., 2006).

Not only did this change turn off many students from science, but it also acted to constrain the development of most pupils to their full potential. When children became “turned off” or completely disinterested, science teachers brushed it off as the student’s lack of ability.

This problem persisted for over a century and continues to affect students up to generation Z (Mji & Makgato, 2006). The withdrawal from science by many students once it is no longer mandatory in school (note that some high schools require no more than two high school science classes—grades 9 and 10—to graduate) not only creates an environment conducive to scientific illiteracy but may also render a public who become increasingly dependent on the views of scientists to explain everyday occurrences during their lives (Tanchyk, 2022).

By scientific illiterate, I am referring not only to a lack of competence with scientific and technical matters but also a deficiency of knowledge and understanding required to read newspaper articles, follow TV programs, and engage in informed discussions about science (Grba, 2021). A fundamental knowledge of science is essential to understanding contemporary issues concerning one’s health—particularly with respect to SARS, H1N1, Avian Flu virus, Covid, anti-vaccine movements, etc., as well as knowledge of human impact on the environment.

Masses of people are living in a technological society who are scientifically and technologically uninformed (Yaffe, 2022). The American-based National Academies of Sciences, Engineering and Medicine ([NASEM], 2016) have argued that contemporary approaches to teaching science (i.e., school-based curriculum) have been ineffective in satisfying students’ requirements for a functional science consistent with the experiences of students in the real world.

Schools should, at the very least, ensure that all students receive a basic level of literacy in science, as well as challenge those students who are more scientifically gifted. Students must gain literacy in science so they can make well-informed decisions and become responsible adults. By scientific literacy, I am not referring to a specific body or content of knowledge but to a general ability to follow the reasoning in science (PISA, 2013).

Perhaps there is no clearer example of the need for greater scientific literacy than the COVID pandemic and subsequent overflow of information available to the public. Undoubtedly, a greater comprehension of science would be of tremendous value to students for being able to remain objective while applying a critical lens to understanding the coronavirus and how it impacts their lives (Crowell & Addy, 2018).

While there is no universally accepted and undisputedly correct definition of scientific literacy, the objective of school science should be to enhance students’ educational development. Science education should not simply be about producing research scientists to remain competitive with other countries on a global scale if the goal is to enrich all students’ understanding of science. Moreover, scientific literacy must also reflect cultural awareness.

Unfortunately, the traditional science curriculum leaves students foreign to their own culture (Boutte et al., 2010). Thus, the provision of appropriate experiences in school science could be seen as a means of helping students better relate to themselves, and others, while understanding

who they truly are. An essential component of science education is stimulating interest in the subject, regardless of whether a student will become a research scientist (Brunsell et al., 2014).

The sad reality, however, is that many students are left feeling alienated by their school science experiences (Blum, 2012). What is needed is an approach that would help students overcome their general feelings of hostility toward science. For many students, school science is perceived as extremely “subject-oriented” and not “learner-oriented.” Students view science as a method and often believe that they must subordinate a sense of themselves to this method. There is a longing to learn about usable science, practical applications, and how science could be contextualized in the real world (Germain, 2019).

Science, as both a subject in school and a means for understanding the interrelationships between science and society, is far too valuable to be limited to just a select few. Science is part of necessary preparation for modern life. Scientific ways of thinking can be applied in all practical affairs, and everybody needs to appreciate how understanding science can enhance their life (Brotman & Mensah, 2008). Science is essential knowledge and must not be restricted to a distinct group of people. All citizens need a functional understanding of scientific concepts to make informed decisions regarding their health and the environment, pursue careers in technological fields, and think clearly. By keeping many students scientifically illiterate, a significant group of the population remain incapable of making educated, informed choices on science-related issues and how these issues impact their everyday lives (Pasek, 2018).

In trying to understand scientific knowledge, everyday citizens have often had to rely on the mediation and interpretation of an established group of eminent specialists. I believe that science knowledge, or knowledge of science and related issues, is a “common good.” Scientific literacy is about empowerment. It is about letting students understand science’s impact on their lives; it is about enabling students to make sensible decisions and become responsible human beings. Educators must ensure that science is accessible to all citizens. Students should come to understand what science is and then be allowed to make decisions on their own. Knowledge of science, as a way of thinking, a way of knowing, and a way of understanding the world around us, can help students better understand the values and conditions affecting their lives. The goal must be to help all students become scientifically literate (Snow & Dibner, 2016).

Curriculum Studies

While the term curriculum, as a course of study, came into prevalent use in North America in the late nineteenth and early twentieth centuries, numerous scholars have struggled with the meaning of “curriculum studies” (Schubert, 2022). Consequently, the curriculum has come to mean many different things to different people. The term is so equivocal that there is considerable inconsistency even amongst leading experts. Maryanti et al. (2021) describe it as a slippery concept, a weasel word surrounded by much ambiguity. To some, curriculum represents volumes of uninterpretable materials that are unattractive, uninteresting, and overpowering. Conversely, others view the curriculum as the very soul of the school that embraces students’ lives (Macalister, 2019).

The Ontario Institute for Studies in Education of the University of Toronto [OISE], an international leader in educational research and activity, defines curriculum studies as a forum for systematic reflection on the substance (subject matter, courses, programs), purposes, and practices used for bringing about learning in educational settings (OISE, 2021, p. 39). The Department of Curriculum, Teaching and Learning at OISE concerns itself with fundamental

issues as what should be studied? Why? By whom? In what ways? And in what settings? “Reflection upon such issues involves an interplay among the major components of education: subject matter, learning, teaching, and the larger social, political, and economic contexts as well as the immediate instructional situation” (OISE, 2021, p. 39). Regardless of one’s interpretation, perhaps the most visible feature of the curriculum is that it focuses on what is to be learned.

Progressive advancements in curriculum, however, do not occur outside the realm of normal, everyday activity. Changes in knowledge (including knowledge about learning), and political and economic developments have significantly influenced what is taught in schools (Murr, 2021). For example, science education from the 1950s to the 1970s was greatly affected by launching the first Russian Sputnik satellite. Many North Americans perceived this as a serious political threat, and school science embraced a mandate geared toward producing research scientists, which strongly influenced the type, content, and nature of science pupils received in schools (El Takach & Yacoubian, 2020). Notwithstanding, during times of crisis, schools have been more concerned with helping students understand the dilemmas and social issues impacting contemporary society (Hawick et al., 2017).

More recently, efforts directed at curriculum reform have been strongly driven by economic and commercial needs. Such was the case in the 1980s when fear of North America’s inability to keep up with growing foreign markets, particularly the relatively cheap supply of labor in Asia, greatly influenced the curriculum in science. Indeed, some perceive school science education as essential to producing the scientific and technological professionals who will enable the USA to compete economically with global markets (Carnoy, 2014).

But the curriculum is about so much more than pursuing current doctrines or contemporary trends. While no single course of study can guarantee the desired outcome, the curriculum should not be exclusively about efficiency, competence, or cost-effectiveness. Curriculum needs to extend beyond present-day political or economic needs. It should be about more than just satisfying financial and industrial requirements defined by the few (Henderson et al., 2018). Curriculum needs to respond to the real crisis in society; the necessity to make science more accessible to all students to make more people aware of the role science plays in their everyday life. Science curriculum should be about education for responsible citizenry: helping people fight their feelings of powerlessness and helping students build their confidence in the real world. The curriculum must be connected to the lives of students. Education is a process that necessitates an embodiment of the finest elements of what makes people human and liberates them in teaching people what is of value.

Similarities Between Curriculum Studies and Scientific Literacy

Tyler (1949), in his landmark book titled *Basic Principles of Curriculum and Instruction*, asks, “what educational purpose should schools seek to attain?” (p. 1). He perceives the curriculum as a set of educational objectives and schools as the agency for helping students meet these goals. Tyler appeals for responses to the question, “what can your subject contribute to the education of young people who are not going to be specialists in your field; what can your subject contribute to the layman, the garden variety of citizen” (Tyler, 1949, p. 26).

Concerning science education, Tyler (1949) suggests that science, for the “garden variety of citizen,” could help provide a clearer understanding of the world as it is viewed by the scientist and man’s relation to it and the place of the world in the larger universe. This type of awareness

would assist in extending a student's range of perceptions, helping them view the world more clearly and critically. It could help students see beyond the obvious. Through developing interests and values in science, students will then be able to express themselves and communicate more effectively (Tyler, 1949). Thus, educational objectives in non-specialist subjects (i.e., English students enrolled in a mandatory science course) can contribute to the larger pedagogical goals of broadening students' vision and perspective of the world around them. "Science can be taught to encourage reflective thinking and to develop other characteristics of personality such as creative thinking, aesthetic appreciation, tolerance, social sensitivity, and self-direction" (Tyler, 1949, p. 32). Tyler views these characteristics, along with strong democratic values, as essential to helping students lead satisfying and fulfilling lives. He also firmly believes that these ideals are what all educational programs (i.e., the curriculum) of the school should aim for.

Long considered an innovator in the field of curriculum studies, Ralph Tyler's work challenged the philosophical assumption of whether there should be a further education for different classes of society—this assumption is the basis upon which the "Science for All" movement was founded. One of the primary goals of the "Science for All" movement is to ensure that all students obtain a fundamental capacity to understand and express their views on science-related issues (DeBoer, 2019). And suppose one believes in the value of a common democratic education for all, in that case every effort should be made to select common objectives that are personally and socially significant to a wide variety of young people. Tyler probed this query further by asking whether public school education should strive primarily toward the general education of the everyday citizen or at specific vocational preparation (Bhuttah et al., 2019).

Note that public school education is about the North American system. If one holds to a more generalized theory of learning, then they (i.e., educators) would come to view learning objectives in more general terms and believe in the value of teaching all children to apply scientific principles in explaining everyday phenomena.

Conclusion

Throughout this paper, considerable attention has been directed towards demonstrating how traditional approaches to science education have failed to provide many North American students with a basic functional understanding of science as a method for understanding the world. Arguments have been made for the "Science for All" movement in assuring scientific literacy and equality of educational opportunity to the broader population of students.

By examining the meaning and purpose of curriculum studies, this work has also highlighted similarities between the larger field of curriculum and the domain of scientific literacy. In doing so, I have demonstrated that the problem of illiteracy in science requires systematic and methodical consideration. Consequently, it is within the larger field identified by the term curriculum studies that science education could truly begin to address the needs of a North American society which demands a functional level of scientific and technological knowledge for all (Campbell-Phillips, 2020). Only by reflecting on the methods used for teaching and learning, as well as content and subject matter, can the domain of curriculum studies begin to effectively focus on how curriculum could best be structured to meet the needs of society.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

Generative AI and AI-assisted technologies were not used in the writing process.

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An Evaluation of the Athlete Leadership Development Program at National University

Reine Joshua L. Cruz, National University, Philippines
Mariano Thomas S. Ramirez, De La Salle University – Dasmariñas, Philippines

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Abstract

This study examined athletic leadership development programs at National University (NU), evaluating implementation, effectiveness, challenges, and improvement opportunities. Employing a mixed-methods design, the research collected quantitative and qualitative data via questionnaires and interviews with varsity athletes. Four guiding questions framed the inquiry: which leadership programs are implemented; what leadership roles and skills are developed; what challenges athletes encounter; and what improvements are appropriate. Results indicate NU provides a comprehensive program emphasizing core competencies, communication, decision-making, and conflict resolution with communication most prominently stressed. Delivery methods combine group coaching, one-on-one mentoring, leadership workshops, and experiential learning such as team drills, aiming to build individual leadership capacity and strengthen team cohesion. Despite these strengths, participants reported implementation challenges. Athletes described difficulty balancing academic, athletic, and leadership commitments, leading to fatigue and stress. They also noted the program's rigid scheduling, insufficient emotional and psychological support, and overly academic content that lacked practical application. To address these gaps, the study proposes the NU Athlete Leadership Development Program (NALDP), a four-year, cohort-based model that begins with emotional intelligence training and advances to strategic leadership development. NALDP integrates leadership camps, reflective journaling, scenario-based simulations, and continuous assessment through peer evaluations and leadership portfolios. Designed to be adaptive and experiential, the program aligns with athletes' schedules and real-life contexts, fostering sustained leadership growth at both individual and team levels. Implementation of NALDP should include stakeholder consultation, flexible scheduling, and integrated mental health resources; pilot testing and iterative evaluation will ensure relevance, feasibility, and measurable impact on athlete leadership outcomes.

Keywords: athlete leadership, varsity athletes, leadership development, experiential learning, mixed methods

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Introduction

The governance of sports plays a crucial role in fostering leadership by establishing frameworks that prioritize values, ethical practices, and opportunities for development. Through programs initiated by sports governing bodies, such as coach certifications and athlete mentorship initiatives, leadership training is embedded into the fabric of athletic development. These programs emphasize essential leadership skills like communication, conflict resolution, and ethical decision-making, preparing individuals to guide teams effectively. Governance also ensures inclusivity in leadership roles by promoting representation across diverse genders, cultural backgrounds, and age groups, enriching the quality of leadership within sports teams and organizations.

Effective sports governance not only nurtures individual leadership qualities but also creates environments where team dynamics and collective leadership could thrive. According to Cotterill (2016), leadership is the cornerstone of team success, enhancing cohesion, communication, and overall performance. By embedding ethical principles and equitable practices into decision-making processes, governance supports leaders in fostering trust, collaboration, and a culture of shared responsibility. This synergy between governance and leadership development drives the evolution of sports as a platform for personal growth, team excellence, and community impact. The importance of athletic leadership extends beyond the confines of the sports arena. As Day and Dragoni (2015) point out, leadership development in sports could have far-reaching implications, influencing not only the success of athletic programs but also the personal growth and future career trajectories of student-athletes. By instilling leadership qualities such as resilience, responsibility, and strategic thinking, sports programs can equip athletes with skills that are transferable to various aspects of life. In this regard, the development of leadership within athletic programs is not just a matter of competitive success but also a vital component of holistic athlete development.

In recent years, National University (NU) has emerged as a dominant force in collegiate sports, consistently achieving top rankings and demonstrating a robust winning culture across various leagues. According to reports published on the NU website, varsity athletes have excelled in competitions such as UAAP Season 86 and other national tournaments, securing gold medals and podium finishes across various sports. This success is not solely attributed to the athletic prowess of the athletes but also to the university's commitment to comprehensive sports leadership development programs. These programs are designed to foster leadership qualities among athletes, thereby enhancing team cohesion and overall performance.

The development of leadership at National University (NU) has been integral to its mission of cultivating well-rounded individuals equipped to excel in their academic and professional pursuits. Founded in 1900 as Colegio Filipino, the institution has evolved through the years to prioritize leadership as a key aspect of its educational philosophy. Leadership initiatives have been embedded in both academic and extracurricular programs, fostering a culture of engagement and mentorship among students, faculty, and staff. NU's transformative partnership with the SM Group in 2008 marked a turning point, enabling significant advancements in infrastructure, student-centered policies, and leadership training. These efforts reflect NU's commitment to producing graduates who are not only skilled in their fields but also capable of driving meaningful change in their communities.

NU employs innovative strategies to promote leadership development and to ensure its integration into all aspects of university life. By emphasizing practical learning experiences

such as leadership workshops, collaborative projects, and community service, NU provides students and faculty with opportunities to build essential skills like communication, teamwork, and strategic thinking. The NU Leadership Development Program (NU LDP) exemplifies this focus, offering comprehensive training designed to nurture ethical and socially responsible leaders. Marketing strategies highlight the university's modern facilities, academic achievements, and leadership opportunities, positioning NU as a top choice for students seeking holistic growth. Through a combination of strategic planning and leadership-focused initiatives, NU continues to empower individuals and solidify its role as a leader in higher education and leadership development in the Philippines.

While athletic leadership development programs are integral to cultivating student-athlete leaders, there is limited research specifically evaluating the effectiveness of such programs at the collegiate level, particularly within the context of Philippine universities. Studies on leadership development in athletics often focus on professional or international settings, with insufficient attention to local contexts like the National University. Additionally, existing evaluations tend to emphasize the immediate impact on athletic performance or team dynamics, but few investigate how these programs contribute to the holistic development of leadership skills, both on and off the field.

A literature on athletic leadership development in the Philippine context is largely nonexistent (at the college level, especially the likes of NU at the very least). Professional or international sports have been the focus of most studies and hardly any attention has been given to the local level, through which holistic leadership development is established beyond the playing field. Only few accounts have been made on the cultural and institutional demands of Filipino student-body athletes in a context of tiptoeing between sports, academics, and leadership, resulting in a scant vision of distal outcomes such as career readiness and personal improvement. Another lacuna is in making leadership programs sustainable, and accessible to all students, but particularly for those from historically excluded communities. Attention should be given to this area to make sure that programs that are available to all students to provide long term experience.

Moreover, little is known about how athletic leadership programs address specific cultural and institutional challenges faced by student-athletes in the Philippines, including balancing academic, athletic, and leadership responsibilities. There is also a lack of comprehensive data on the long-term outcomes of these programs, such as their influence on career success, personal growth, and community involvement.

Despite the robust initiatives in leadership development at National University (NU), one challenge lies in ensuring the sustainability and scalability of its leadership programs across all student demographics. While programs like the NU Leadership Development Program (NU LDP) provide valuable training and mentorship, some students, particularly those from marginalized backgrounds or with limited time due to academic and financial pressures, face difficulties accessing these opportunities. This disparity could hinder the university's goal of cultivating leadership qualities equitably among all its students. Addressing this issue requires enhancing the accessibility of leadership programs by introducing flexible formats, such as online modules or hybrid workshops, and increasing awareness and support through targeted outreach initiatives. By tackling these barriers, NU can ensure that its leadership initiatives reach a broader audience, fostering a more inclusive environment where all students have equal opportunities to develop and excel as future leaders.

The NALDP is a key component of the NU sports development program under the university's overall sports management headed but the sports director. Incorporating leadership development within its athletic governance, the initiative reaffirms the university's pledge to developing student-athletes as leaders on the field and court, in the classroom and in the community. Such alignment ensures that student-athletes will acquire core skills in communication, decision making, and conflict resolution, within ethical frameworks and through commitments to values which are consistent with the educational mission at NU. The school recognizes this union of sports success and leadership is positive for the school, students and wider community, as it helps to develop a culture of sports success as part of a well-rounded development. This provides more opportunities for students to be challenged in their personal and professional development and be ready to lead not exclusive of their higher education.

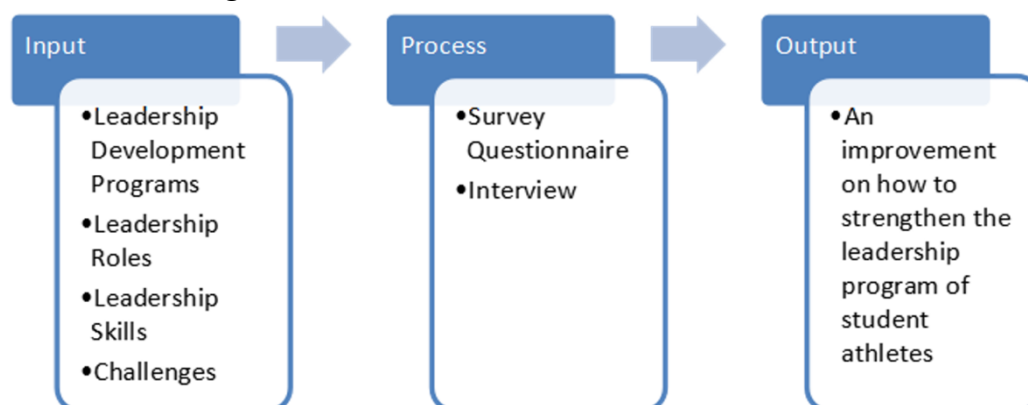
In a parallel stroke, the program plays into NU's branding of the University itself, allowing prospective students to see how sports attract interest and attendance at the school. But even completely successful athletic programs, like that supported by a leadership development program, will entice prospective enrollees by touting NU's dominance in competitions as well as the university's well-rounded support of student-athletes. All this success adds up to more overall school reputation, increased community pride, and a greater lure for incoming students who now see NU as a place where sports and leadership intersect. Despite this, the paper suggests that there are issues in maintaining and enabling such initiatives, from resource shortfalls to issues of access, which prevent NU from reaching its full athletic potential. These gaps need to be addressed if NU athletics program's support issue is to be resolved, and if the development of sports is to be maximized, not just for sports advancement, but also for student development, long-term play strategies, and for the long-term sustainability of the institution.

Despite efforts of such undertakings, a gap still exists in determining the effectiveness of athletic leadership programs in Philippine universities, specifically in the case of NU. Most extant studies centered on professional or international sports, ignoring the challenges and experiences of Filipino student-athletes as they juggle their academics with their athletic training and leadership. Comparatively, little is known also about the long-range effects of such programs and what role are they play in preparing students for careers, or in providing students with a wide-view of the world, or in impacting the community. With this gap in mind, this study aims to offer evidence-based contributions that will not only enhance the athlete leadership development at NU but can also be followed as a model for other universities who intend to combine sport governance and leadership training gaps.

This study aimed to evaluate the athletic leadership development programs at NU. By identifying the strengths and weaknesses of the current initiatives, this research sought to provide actionable insights that could support the expansion of NU's sports programs nationwide. Additionally, this study holds significance for other NU campuses, which could adopt best practices from NU to enhance their athletic success. The findings are expected to contribute to the field of sports leadership by offering a model for effective leadership development in collegiate sports, thereby supporting the academic and athletic development goals of the university.

Research Paradigm

Figure 1
Research Paradigm



The research paradigm presents an input-process-output research model. In the input component, the study focuses on leadership development programs, which are designed to enhance leadership skills and competencies among individuals or groups. These programs can vary in terms of their structure, content, and delivery methods. Different leadership roles within these programs were examined, such as team leaders, project managers, or mentors. This helps to understand how leadership development programs address specific leadership roles and their associated responsibilities. The research analyzed the development of various leadership skills through the programs, including communication, decision-making, problem-solving, conflict resolution, and teamwork. These skills are essential for effective leadership and could be fostered through targeted leadership development initiatives.

For the process component, the study employed both survey instruments and interviews to gather comprehensive data on participants' experiences and perceptions. The surveys provided quantifiable insights, while the interviews offered in-depth qualitative information that enriched the overall analysis.

The output, the study focuses on contextualizing an improvement program aimed at enhancing team cohesion and performance. It assessed the impact of these programs on team cohesion, defined as the degree to which members work together effectively and cooperatively, a factor closely associated with improved performance and satisfaction. The study also evaluated the relationship between leadership development programs and team performance, examining metrics such as productivity, quality, and innovation. Ultimately, the research sought to determine whether participation in these programs leads to measurable improvements in team performance outcomes.

Statement of the Problem

This study aimed to evaluate the athletic leadership development programs at NU, with a focus on understanding their impact on team cohesion and performance.

Specifically, this study inquired on the following questions:

1. What are the leadership development programs implemented at NU in fostering leadership qualities among varsity athletes?
2. How could these leadership development programs of NU be described in terms of

- a. leadership roles; and
 - b. leadership skills?
3. What are the challenges encountered by athletes in the leadership development program of NU?
4. What improvement program may be proposed to strengthen the leadership development program of NU?

The relationship and patterns within the literature on athletic leadership development emphasize the critical role of structured programs in nurturing essential leadership qualities in athletes. These programs are designed to enhance skills like communication, decision-making, and emotional intelligence, which are crucial in complex environments such as sports teams (Machida-Kosuga & Kohno, 2022). A common thread throughout the studies is the focus on self-awareness, collaboration, and experiential learning as key components that contribute to the athletes' personal growth and improved team dynamics (Dugan & Komives, 2021). Many studies reveal that leadership development in sports not only improves the athletes' self-confidence and interpersonal skills but also leads to better organizational outcomes (Bengtsson et al., 2024). Furthermore, emerging evidence indicates that athlete-centered leadership and development programs contribute substantially to the enhancement of key psychosocial competencies, including the cultivation of resilience (Bates et al., 2024), the improvement of time-management capacities (Lamban et al., 2025), and the strengthening of conflict-resolution skills that are foundational to effective functioning within team-based athletic environments (Sports Conflict Institute, 2023).

However, challenges also emerge from the literature, including the need for programs to be culturally sensitive and sustainable. Some studies indicate that existing leadership programs often focus too heavily on individual leadership roles, rather than fostering a collaborative leadership culture (Sutherland et al., 2022). This is where research on shared leadership models, which promote cohesion and trust within teams, becomes relevant. Studies by Cotterill et al. (2022) highlight the importance of both formal and informal leadership in driving team success. Research consistently emphasizes that athlete leadership development, whether through formal roles like captains or informal peer leadership, enhances both team performance and individual well-being.

Coaches are also consistently identified as essential figures in the leadership development process, providing both reactive and proactive leadership that fosters unity, addresses team issues, and sets goals (Peak Consulting Group, 2023). Leadership programs that prioritize personal growth and emotional management have been found to be particularly effective, as they prepare athletes to navigate the emotional challenges of leadership (Machida-Kosuga & Kohno, 2022). Studies in various sports, including cricket and high school sports, demonstrate the positive impact of such programs on both personal development and team cohesion (Cotterill, 2016).

Research consistently highlights that multiple leadership roles within sport teams—including captains, coaches, peer leaders, and other positional leaders—are essential for maintaining discipline, facilitating strategic execution, and sustaining team morale, with captains and coaches providing direct motivational and strategic guidance, and peer or informal leaders contributing significantly to communication, cohesion, and influence within the group (ME-QR Sports Leadership Article, 2023; iResearchNet Sports Leadership Analysis, n.d.; Sports Psychology Teaching Notes, n.d.).

In summary, while athletic leadership programs are widely acknowledged as essential for enhancing both team performance and individual well-being, the literature calls for a more standardized, culturally sensitive approach to leadership development. There is a need for programs to address not only the personal growth of athletes but also the broader team dynamics, ensuring sustainable leadership development across diverse sporting contexts (Cotterill, 2016).

This comprehensive understanding of leadership development can inform future interventions, ensuring that athletes at all levels have the opportunity to develop into wellrounded, effective leaders.

Methodology

This study aimed to evaluate the sports leadership development programs of the National University. To achieve this, a convergent mixed-method design was employed. Researcher uses the mixed methods to expand and improve the analytical power of their studies (Sandelowski M., 2000). Mixed methods research combines quantitative and qualitative approaches to address complex research questions (Sharma et al., 2023). The convergent design involves collecting and analyzing both data types concurrently (Mavodza, 2022). This design is particularly effective for exploring multifaceted research problems that cannot be fully addressed using a single approach (Sharma et al., 2023). Using this singlephase approach, the researcher collected both quantitative and qualitative data, analyzed them separately, and compared the results to see if the findings confirmed or dis-confirmed each other.

The information derived from the study utilizing this design provided a better understanding of the leadership roles and leadership skills, enhancement of leadership development programs and its contribution on the improved team cohesion and team performance of the athletes, which are very essential for effective planning a program for them. The respondents of the study were 340 athletes of National University. Simple random sampling method was used to determine the research respondents.

Simple random sampling, often referred to as the “fishbowl” method, is a technique used in research to select a sample from a larger population where every individual has an equal chance of being chosen. This method involves placing all potential participants or items into a container, such as a fishbowl, and randomly drawing them, ensuring that each item or participant is equally likely to be selected without any bias. It is widely used to ensure a representative sample, particularly when researchers aim for unbiased results. According to Creswell and Creswell (2018), simple random sampling is an essential approach in research design as it allows for the creation of a sample that is truly representative of the larger population, providing valid and reliable results.

For the survey questionnaire, there were 181 respondents from the population of 340. In order to determine the appropriate sample size for this study, a sample size calculator based on Cochran’s formula was used with the following parameters: a confidence level of 95%, a margin of error of 5%, and a population size of 340. Since the actual population proportion was unknown, the default value of 50% was used, as this represents the most conservative estimate and yields the largest required sample size. Based on these inputs, the calculated sample size was 181. This means that at least 181 responses were necessary to ensure that the results of the study were accurate within $\pm 5\%$ of the true population value, with 95%

confidence. For the interview, 10 participants were interviewed: 5 officials/ coaches/ trainers and 5 varsity athletes were interviewed.

The research respondents involved 340 athletes from the National University. Using a Sampling Calculator based on Cochran's formula, there was 181 varsity players considered as the respondents of the study. Moreover, 10 individuals were purposefully selected to participate in the interview phase of the study. This smaller, qualitative subset was chosen to provide deeper insights and a more nuanced understanding of the topic that could not be fully captured through the survey alone. The 10 participants included 5 players and 5 officials/ coaches/ trainers to ensure a balanced perspective between those directly involved in athletic performance and those responsible for management, support, and decision-making. This purposive sampling approach allowed the researcher to explore key themes with more depth, drawing on the lived experiences and expert viewpoints of both groups while maintaining representation across different roles within the varsity sports community at the National University. The researcher utilized an adapted questionnaire based on sports leadership qualities and leadership roles. The first part of the questionnaire determined the student athlete's leadership programs. The second part of the questionnaire focused on how these programs have affected their leadership qualities and leadership roles.

To support the data of the questionnaire, a focus group interview was used. Semi-structured or open-ended interviews are the most common since they provide the greatest chance to distil the essence of the phenomenon at hand (Padilla-Diaz, 2015). In the leadership questionnaire for roles and qualities, the researcher ensured proper permissions and adhered to validation procedures. Since the items in the questionnaire were adapted from established instruments such as the Multifactor Leadership Questionnaire (MLQ) developed by Avolio & Bass (2004), and other validated leadership tools, it was essential to seek permission from the original authors or publishers. Even if the items were revised, the researcher still passed the adapted version through a validation process to ensure its reliability and consistency in measuring the intended constructs.

A semi-structured interview anchored the conversation with participants in the main ideas of the research while simultaneously providing a balance between structure and room for more detailed descriptions of their experiences. Follow-up questions were asked during the semi-structured interview to guarantee that the most accurate representation of the participants' actual experiences were recorded (Padilla-Diaz, 2015).

This study used the Likert scale.

Table 1
Likert Scale

Point	Scale	Verbal Interpretation
5	4.215.00	Strongly Agree
4	3.414.20	Agree
3	2.613.40	Neutral
2	1.812.00	Disagree
1	1.001.80	Strongly Disagree

The research was conducted entirely in accordance with ethical considerations to protect the rights and welfare of the participants. The informed consent was completed before the

participants started with the tasks to have them aware of the aim and procedure of the study and to be alert to possible risks. Participation was strictly voluntary, and the right to withdraw was upheld as well as measures to ensure confidentiality, including de-identification of cases and nondisclosure of identities. The research was reviewed and approved by the university's institutional ethics review committee, and precautions were taken to reduce risk. Results were meant to be used only to enhance the athletic leadership development program at National University considering potential negative impacts.

Survey and in-depth interview data were gathered to describe demographic characteristics, experiences, and views related to program effectiveness. All data were stored in encrypted databases, accessible only to staff with permission to use the information. Pseudonyms were given to ensure participant anonymity. File shifting was kept to a minimum to ensure data integrity, and data was disposed of in accordance with appropriate data security policies following shredding or secure electronic deletion after the retention period. These protocols helped to ensure that the data were dealt with ethically and responsibly at all stages of the research.

Statistical Tools

Several statistical tools and procedures were employed to analyze and interpret the data obtained. Frequency distribution was used to organize responses and show how often each value or category occurred in the dataset, typically through tabular presentation. Percentage was applied to express frequencies as proportions of the total sample, allowing clearer comparison across categories using the formula $(\text{part/whole}) \times 100$. Ranking was utilized to arrange items from highest to lowest based on computed frequencies or mean scores, identifying the most prominent responses. The mean was computed as a measure of central tendency by summing all values and dividing by the number of observations, providing an overall average response level. Weighted mean was also used to summarize Likert scale results and determine the extent to which sports development programs were implemented, as well as to assess team cohesion and team performance indicators. Finally, standard deviation was calculated to describe the variability or dispersion of responses around the mean, indicating the consistency of participants' ratings.

Results

The athletic leadership development programs at NU serve as a critical platform for shaping the leadership potential of varsity athletes, as examined through this study. This study explored the athletic leadership development programs at NU with the goal of evaluating their implementation, effectiveness, challenges, and areas for improvement. The following Statements of the Problem (SOPs) guided the investigation.

1. What are the leadership development programs implemented at NU in fostering leadership qualities among varsity athletes?

NU has vast experience implementing a comprehensive Leadership Development Program for Varsity Athletes, particularly in various key competencies such as Communication, decision-making, and Conflict Resolution; throughout these competencies, Communication stands out as the most prioritized. The program is a combination of group coaching, individual mentoring, leadership workshops, and experiential learning (running team drills).

In both cases, these tools are designed to cultivate leadership at the individual level and collective cohesion at the team level.

2. How could these leadership development programs of NU be described in terms of leadership roles and leadership skills?

The program provides student-athletes with specific definitions for leadership roles and real-life experiences to practice such actions on the field, at practice, or in extracurricular activities. Developed skills, such as emotional intelligence, strategic thinking, and interpersonal communication. Learning is reinforced through self-assessment tools and peer feedback mechanisms. The recognized need exists for more sport-specific, scenario-based simulations that help to train professionals under practical pressure.

3. What are the challenges encountered by athletes in the leadership development program of NU?

Athletes reported feeling fatigued and stressed because they were not able to balance their academic lives, their athletic responsibilities, and leadership roles. This was seen by many as an opportunity to expand, but there were also calls for better program delivery. Such challenges included the very academic language of the program, low availability when it came to emotional and psychological support, and inflexible formats, that would work with an athlete's schedule.

4. What improvement program could be proposed to strengthen the leadership development program of NU?

In response to those gaps, the NU Athlete Leadership Development Program (NALDP) is recommended. This is a four-year, cohort-based model that begins with emotional intelligence training and evolves to strategic leadership and high-performance simulations. It combines reflective journaling with leadership camps and ongoing assessment (e.g., portfolios, peer evaluations). The NALDP is challenging yet fully experiential, an adaptive experience that resonates with the playing context of student-athletes through play-based interactions to enhance individual leadership development and team performance.

Conclusion

This research highlights how important leadership development programs to be structured and intentional for varsity athlete leaders at NU. The present model shows a very good fundamental support: close fields of competency (ability to communicate, take decisions and solve problems). Still, as much as the program itself is complete and all-encompassing in design, in practice there seems to be somewhat of a void between theory and sport-applicable Tenets.

One key finding of this study is that leadership cannot be isolated from the athletic and academic experiences of student-athletes, thus listing a call for shared governance to address these issues. The demands of the multifaceted roles in school, sports, and leadership lay bare the inadequacies of traditional training as it is traditionally taught. Instead, this speaks to a compelling imperative: redesigning the program more athlete-centered around the embedded cognitive, emotional and social components present in student-athletes.

Additionally, although participants mainly felt that they could assume leadership of their respective nodes with confidence, the absence of immersive simulations and role-playing indicates the need to supplement basic training with contextualized practice. Emotional intelligence and mental resilience have been highlighted for further development, indicating that leadership programs should focus not just on role description and procedure tasks but also inner dimensions of leadership: self-regulation, stress management and interpersonal sensitivity.

This study finds, therefore, that NU's leadership training model serves as a solid foundation for effective leadership, but has potential to be further developed and to raise the ranks of longterm efficacy. A promising model to develop such leadership is proposed in the NU Athlete Leadership Development Program (NALPD). The way that its development considers self-knowledge and reputation as well of the kind, adaptable case-study approach showcases a response to the changing high education world. To the extent that the program is implemented with fidelity, the NALDP has potential to heighten overall team culture, improve emotional well-being, and enhance both athletic and academic pursuit of excellence as it enhances individual student leadership capacity.

Recommendations

In light of the conclusion of the study, the following recommendations were drawn:

1. The university needs to toughen up on its leadership development with performance level activities and role-plays set in extreme conditions. Such activities will help athletes to literally practice resolution and decision-making during high-pressure situations, thereby keeping training practical and sport-specific.
2. Modules including emotional intelligence, stress and resilience management, may be incorporated into the curriculum. The resources will aid athletes in dealing with the pressure of academics and athletics and enhancing teamwork, flexibility, and collaboration abilities.
3. Because of time constraints, programme design must be flexible and sport-specific. By providing a mix and match of modalities (e.g. async and selfpaced) will help meet the needs of athletes who have very busy training and competition schedules.
4. The plan of action should include a focus on the involvement of the athletes, reflection, and communication. This involves the implementation of unattributed feedback systems, peer-mentoring and reflective diaries, followed by the introduction of interpersonal communication and conflict resolution training targeting specific issues that emerge from the interviews.
5. The long term impact of athletic leadership development programs beyond the university context needs to be explored in future studies. Longitudinal data collection with NU graduates followed up and their professional and civic achievements could be an excellent means to tracking NUSL turkeys. Further, comparative and longitudinal studies can help provide indicators about how leadership competencies of turkeys might be maintained over time, and contrast between athlete-student leaders and non-athlete-student leaders.
6. Considering the scope and limitations of the present evaluation, the researcher recommend that future research should be directed at investigating long-term effects of athlete leadership development programs in post-university life.
 - a. This may involve monitoring NU alumni to determine the impact of the leadership program on their professional lives, civic involvement, and subsequent sport leadership participation.

- b. Longitudinal studies of this nature would enhance understanding of the extent to which these leadership skills are sustained and applied in practice.
- c. Future studies may also explore a comparison between varsity athletes and non-athlete student leaders to identify contrasts in leadership development achievements, concerns, and desired training strategies.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author utilized several AI-assisted tools to support data analysis and manuscript preparation. SPSS Statistics v.28 was used for data coding and statistical computations, including descriptive and inferential analyses. NVivo facilitated the organization, coding, and thematic analysis of qualitative data. Grammarly assisted in improving grammar, clarity, and overall writing quality, while QuillBot was used selectively to enhance phrasing and ensure clarity and conciseness. An AI content checker helped verify the authenticity of the work, ensuring that AI-generated elements did not compromise originality. Finally, plagiarism detection software such as Turnitin or Grammarly Plagiarism Checker was employed to confirm proper citation, ensure academic integrity, and minimize similarity.

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Contact email: rjlcruz@nu-dasma.edu.ph

Designing Inclusive Data Science Literacy for Non-STEM Majors: A 2023 Baseline and Design-Based Extensions Through 2025

Yuko Murakami, Hiroshima University, Japan
Rie Enomoto, Kokushikan University, Japan
Yoshinori Honma, Kokushikan University, Japan
Tomohiro Inagaki, Hiroshima University, Japan
Naoki Itoh, Kokushikan University, Japan
Ryosuke Oyanagi, Kokushikan University, Japan
Motoo Sekiguchi, Kokushikan University, Japan

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Abstract

Japan's government has strongly promoted mathematics, data science, and AI literacy across higher education. However, universities respond differently depending on student demographics and institutional philosophy, leading to unique designs for data science education. Against this backdrop, we asked a common question: Does such education raise students' motivation to engage with data science? In 2023, we delivered a university-wide, on-demand literacy course to students from seven faculties ($N \approx 2,000$). Pre/post surveys with eight Likert items (mapped to Self-Determination Theory: autonomy, competence, relatedness) were analyzed using two-way repeated-measures ANOVA (time $\times$ faculty). Open-ended comments and learning-management logs were used to enrich interpretation. Results showed significant pre-post change on most items, but with notable faculty-level interactions. Gains in perceived fairness of AI and enthusiasm were clear in some groups. In contrast, competence-related confidence declined among others, suggesting that a scalable, on-demand format does not support all learners equally. Guided by these findings and informed by national initiatives at comparable universities, we designed a 2024–2025 expansion plan. This includes exploring the introduction of collaborative learning supported by generative AI, aligning tasks with SDT to strengthen autonomy and competence, and refining documentation of course architecture and engagement metrics. We present the 2023 baseline, explain how it influenced subsequent redesigns, and outline a 2026 evaluation plan that links attitudinal change with behavioral indicators. This work highlights how national policy meets local educational diversity, and how design-based improvement can advance scalable yet inclusive data science literacy.

Keywords: AI literacy, generative AI, first-year university students, data science education, self-determination theory, design-based research

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Introduction

Data science and AI literacy have become foundational competencies for all university students, not only those in STEM disciplines (OECD, 2019). In Japan, national initiatives such as Society 5.0 and the AI Strategy 2019 have heightened expectations that higher education will provide scalable, institution-wide training in data science and AI (Cabinet Office, n.d.; Integrated Innovation Strategy Promotion Council, 2019). However, “one-size-fits-all” course designs can unintentionally amplify disparities: students’ prior experience, academic identity, and learning environment shape whether large-scale education improves motivation and confidence.

This study reports on the 2023 baseline implementation of an on-demand AI/data science literacy course at a private university and connects the baseline findings to a design-based extension through 2025, in a new reality: generative AI has become embedded in everyday academic life (OpenAI, 2023; UNESCO, 2023). Rather than treating 2023 and 2025 as directly comparable datasets, we emphasize the reinterpretation of how the meanings of students’ motivation and competence shift in a post-generative AI context.

Policy Background and Problem Shift (2023 to 2025)

Japan’s policy vision for a “super-smart society” positions data science and AI literacy as key drivers of innovation across sectors (Cabinet Office, n.d.; MEXT, 2022). Universities are therefore expected to provide basic literacy to all students. Previous studies have examined how existing computer literacy courses can be adapted to data science education in Japanese universities, highlighting both opportunities and limitations in curriculum reuse (Arahira & Hashizume, 2022). However, institutional responses vary substantially depending on mission, curriculum structures, and student populations. For example, national universities such as Shiga University have developed institution-wide frameworks to foster data science human resources, illustrating how institutional mission shapes educational design (Tanaka et al., 2022). These differences are especially salient for non-STEM majors, who may have limited prior exposure to technical content and may not see immediate relevance to their academic goals.

The educational landscape changed dramatically between 2023 and 2025. In 2023, many students had little hands-on experience with generative AI. By 2025, generative AI tools will be widely accessible and routinely used for learning and productivity (OpenAI, 2023; UNESCO, 2023). This diffusion creates a methodological and interpretive challenge: the same survey item (e.g., perceived competence) can reflect different underlying concerns before and after generative AI becomes ubiquitous.

Research Questions

This study aims to examine first-year university students’ impressions of AI, with particular attention to how these impressions should be interpreted in the current era of generative AI. It focuses on both students’ initial impressions and the changes observed during course participation. The following questions guide the research:

- RQ1. What impressions of AI (including generative AI) do first-year university students hold at the beginning of an introductory data science course?
- RQ2. How do these impressions change before and after participation in the course?

By addressing these questions, this study seeks to clarify how early-stage university interventions may influence students' perceptions of generative AI and to provide insights into the design of AI literacy education.

Methods

Course Context (2023 Baseline)

We implemented a university-wide, on-demand literacy course intended for broad participation across seven faculties. At Kokushikan University, this literacy course is positioned within the university's AI and Data Science minor program, and the core subject "AI and Science" has been implemented as a university-wide, on-demand requirement since 2023 (Itoh et al., 2024). The course aimed to raise awareness of AI and data science in daily life, while introducing basic concepts and applications. Because the 2023 baseline survey was administered before generative AI became widely adopted in the classroom, the items were originally framed in terms of "AI" in general; in this paper, we interpret these responses as a baseline for students' emerging perceptions of generative AI in later course contexts (Murakami et al., 2018).

Participants and Data

In 2023, pre- and post-course questionnaires were administered to over 2,000 enrolled students, yielding approximately 1,600 valid responses per survey wave across seven faculties. Items were rated on a 7-point Likert scale. In addition, learning management system (LMS) quiz submission records were used descriptively to examine engagement patterns across units. Open-ended comments were collected to enrich interpretation. Survey's target faculties were: Political Science and Economics (F1), Physical Education (F2), Science and Engineering (F3), Law (F4), Literature (F5), Twenty-First Asia (F6), and Business Administration (F7).

Measures and Theoretical Framing

To interpret student motivation, we adopted Self-Determination Theory (SDT), which emphasizes three basic psychological needs—autonomy, competence, and relatedness—as conditions for sustained engagement. Survey items were mapped to SDT-inspired categories and analyzed at both the item and category levels (Deci & Ryan, 1985, 2000; Ryan & Deci, 2017).

In this study, SDT-inspired categories were operationalized as follows. Autonomy was assessed using items Q1 and Q6. Relatedness was assessed using items Q2 and Q3, which reflect students' perceptions of social connection and relevance in learning about AI (including generative AI in later course contexts). Competence was assessed using items Q4, Q5, Q7, and Q8, which captured students' perceived ability, confidence, and understanding of AI (including generative AI in later course contexts). These categorizations were used consistently across descriptive and pre-post analyses. All responses were coded so that higher scores indicate stronger agreement (1 = strongly disagree, 7 = strongly agree).

Analytical Approach

Baseline Analysis (2023)

We conducted a two-way repeated-measures ANOVA with Time (pre/post) as the within-subjects factor and Faculty as the between-subjects factor, using paired responses from students who completed both surveys. Qualitative comments and LMS logs were referenced to contextualize patterns and to suggest plausible mechanisms behind the changes.

Interpretive Extension (2025)

To discuss changes under a post-generative AI environment, we reorganized questionnaire items into three SDT-inspired categories and compared category means descriptively across datasets. Importantly, our goal is not a strict statistical comparison across years, but rather to clarify how the meanings of “motivation” and “competence” evolve as generative AI becomes embedded in academic life (OpenAI, 2023; UNESCO, 2023).

Results

2023 Baseline Study (Before Generative AI Became Ubiquitous)

The on-demand course increased students’ interest in AI and their perception of its relevance to their lives. Across multiple items, significant pre-post changes were observed, and faculty-level interactions indicated that some student groups benefited more than others. Table 1 summarizes the results of the two-way repeated-measures ANOVA examining pre-post changes and faculty differences.

Table 1

Results of a Two-Way Analysis of Variance (ANOVA) for Each Survey Item

SDT Category	Item	Source	F-value	p-value	Partial η^2
Autonomy	Q1	Faculty	5.2859	< .0001	.0112
		Pre/Post Class	5.0906	.0242	.0014
	Q6	Faculty	5.0107	< .0001	.0133
		Pre/Post Class	5.2658	.0219	.0009
Relatedness	Q2	Faculty	1.8956	.0782	.0041
		Pre/Post Class	927.69	< .0001	.1586
	Q3	Faculty	4.8931	.0001	.0123
		Pre/Post Class	2.6005	.1070	.0005
Competence	Q4	Faculty	6.4226	< .0001	.0164
		Pre/Post Class	6.3177	.0121	.0012
	Q5	Faculty	2.6851	.0135	.0066
		Pre/Post Class	39.4221	< .0001	.0083
	Q7	Faculty	2.1221	.0481	.0055
		Pre/Post Class	4.1911	.0408	.0008
	Q8	Faculty	3.4573	.0021	.0091
		Pre/Post Class	58.6774	< .0001	.0107

Note. Partial η^2 indicates effect size.

To facilitate interpretation of these results, Table 2 presents faculty-level mean scores for each item at the pre- and post-survey timings. A key pattern was an “interest–competence gap.” While autonomy- and relatedness-related indicators improved (e.g., greater interest and perceived societal relevance), competence-related confidence did not improve commensurately and in some groups even declined. This suggests that scalable online instruction may raise awareness and curiosity without consistently developing technical self-efficacy.

Table 2
Faculty-Level Mean Scores for Each Survey Item

SDT Category	Item	Period	F1	F2	F3	F4	F5	F6	F7
Autonomy	Q1	Pre	5.19	5.09	5.37	5.07	5.35	5.04	5.39
		Post	5.31	5.07	5.54	5.36	5.27	5.09	5.55
	Q6	Pre	5.37	5.45	5.72	5.62	5.37	5.18	5.70
		Post	5.40	5.23	5.61	5.50	5.27	5.61	5.70
Relatedness	Q2	Pre	3.04	2.82	3.05	3.17	2.92	2.85	2.91
		Post	4.25	4.15	4.35	4.32	4.04	4.22	4.35
	Q3	Pre	5.48	5.55	5.83	5.88	5.65	5.60	5.66
		Post	5.48	5.38	5.73	5.74	5.63	5.51	5.80
Competence	Q4	Pre	4.52	4.69	4.50	4.80	4.22	4.57	4.70
		Post	4.61	4.69	4.79	4.57	4.22	4.92	4.92
	Q5	Pre	5.26	5.24	5.31	5.41	4.97	5.27	5.59
		Post	5.40	5.45	5.57	5.50	5.35	5.32	5.34
	Q7	Pre	4.44	4.68	4.46	4.17	4.32	4.80	4.39
		Post	4.40	4.49	4.36	4.39	4.56	4.42	4.39
	Q8	Pre	4.68	4.59	4.85	4.81	4.66	4.73	4.91
		Post	4.97	4.92	5.22	5.06	4.88	4.79	5.33

Note. Analyses are based on students who responded at each survey timing within each faculty. Due to late attendance and additional responses collected during class, sample sizes differ between pre- and post-surveys across faculties. (e.g., F1: Pre N = 443, Post N = 379; F2: Pre N = 341, Post N = 376; F3: Pre N = 274, Post N = 237; F4: Pre N = 351, Post N = 281; F5: Pre N = 327, Post N = 296; F6: Pre N = 260, Post N = 243; F7: Pre N = 224, Post N = 188). The ANOVA was conducted using available paired responses within faculties.

Interpretive Extension (2025) results are summarized separately to avoid conflating datasets. Table 3 reports unpaired descriptive statistics for the SDT-based category aggregates in 2025 across two survey waves. Because the 2025 results are presented for interpretive purposes rather than for direct pre–post testing, they should not be statistically compared with the 2023 baseline results.

However, the interpretation of “low competence” changes. In 2023, lower competence primarily reflected limited prior exposure and fewer opportunities for hands-on learning. In 2025, similar responses may capture qualitatively different concerns, such as (a) reliance on AI as a cognitive shortcut, (b) anxiety about excessive or inappropriate use, and (c) blurred boundaries between “knowing” and “using AI.” Therefore, time-aware interpretation is essential when using stable survey items across rapidly changing technology contexts.

Table 3
Category Means From Two Survey Waves (Unpaired)

SDT Category	Mean (Pre wave) N = 1764	Mean (Post wave) N = 2053	Δ (Post–Pre)
Autonomy	5.25	5.51	+0.26
Relatedness	4.53	4.72	+0.19
Competence	2.93	3.44	+0.51

Note. Table 3 summarizes 2025 descriptive results at the category level across two survey waves labeled “Pre” and “Post.” These waves are not based on matched individual pairs; therefore, the Ns may differ (e.g., due to late participation or additional respondents), and the values should be interpreted as unpaired descriptive summaries rather than as within-student pre–post changes.

Design-Based Extensions (2024–2025) and 2026 Evaluation Plan

Guided by the 2023 baseline, we designed a 2024–2025 expansion plan to improve inclusiveness and support competence development. Related case studies have shown that carefully designed instructional interventions can enhance undergraduate students’ motivation to engage with AI-related topics (Murakami et al., 2024). Key directions include introducing collaborative learning opportunities, aligning tasks with SDT (Deci & Ryan, 2000; Ryan & Deci, 2017) to strengthen autonomy and competence, and leveraging generative AI to reduce language and communication barriers in group activities.

For 2026, we outline an evaluation plan that connects attitudinal change with behavioral indicators. In addition to pre- and post-surveys, we plan to incorporate engagement traces (e.g., LMS activity, assignment/quiz submissions) and to document course architecture and learning support structures to enable transparent replication and cross-institutional comparison (UNESCO, 2023).

Discussion

This study illustrates how shared policy-level goals for AI literacy may play out differently in local course settings. Even when learning objectives are aligned, students’ responses and perceived learning outcomes can vary depending on faculty characteristics and the learning environment. The observed interest-competence gap suggests that raising interest is necessary but insufficient for inclusive AI literacy; learners also need structured opportunities to build competence and confidence through guided practice, timely feedback, and social support (Ryan & Deci, 2017).

While this study does not provide a direct institutional comparison, the results indicate that differences in course design and educational context can meaningfully shape how first-year students interpret and respond to generative AI. Therefore, the design of introductory courses should prioritize not only motivating content but also scaffolding that reduces anxiety and supports early success experiences (UNESCO, 2023).

The post–generative AI environment complicates the interpretation of “AI readiness.” As generative AI becomes a routine tool, educational research should distinguish between confidence in tool use and conceptual understanding, and address emerging ethical and epistemic concerns, including overreliance and the appropriateness of its use in academic work.

Conclusion

In the pre-generative AI baseline (RQ1), the 2023 baseline revealed a clear interest-competence gap in students' perceptions. In the post-generative AI context (RQ2), the same pattern persists, but the meaning of competence-related responses must be reinterpreted under new learning conditions. Overall, time-aware, design-based perspectives are essential for advancing scalable yet inclusive AI and data science literacy.

The revised 2025 survey instrument is publicly available to promote transparency and facilitate future collaboration.¹

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that Grammarly, an AI-assisted writing tool, was used to proofread and refine the manuscript's language. The use was limited to correcting grammatical and spelling errors and to rephrasing statements to improve accuracy and clarity. The author further declares that, apart from Grammarly, no other AI or AI-assisted technologies have been used to generate content in writing the manuscript. The ideas, design, procedures, findings, analyses, and discussion are original and derived from the appropriate and systematic conduct of the research.

¹ The survey instrument is available via Microsoft Forms at:
<https://forms.office.com/Pages/ShareFormPage.aspx?id=3VQExGOyJkmGjY4SZA03UFixcM1E-VdBqU845cOTGLRUNTY4WDhQMFA2VIRLUIYwRldBQzE2Q1dTOS4u&sharetoken=wQTyHjDtHMAse4lbTd85>

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Contact email: yuk0mura@hiroshima-u.ac.jp

Attitude, Involvement, and Capability in Librarianship Among Librarians in BRLC

Jose Leandro M. Lanuzo III, Dr. Emilio B. Espinosa Sr. Memorial State College of
Agriculture and Technology, Philippines

Pedrito Jose V. Bermudo, University of Perpetual Help System Laguna, Philippines

Abigail B. Sadueste, Daniel B. Peña Memorial College Foundation, Philippines

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Abstract

Findings revealed that librarians of Bicol had a very positive attitude towards librarianship with an average weighted mean of 3.71. For the respondents' level of involvement, librarians had a very high level of involvement in librarianship with an average weighted mean of 3.57 and the librarians had a "very high" level of capability in librarianship with an average weighted mean of 3.60. There was a significant difference in the respondents' level of involvement in librarianship when grouped according to educational attainment ($\chi^2 = 12.440$; $p = 0.002 < 0.05$). And there was a significant difference in the respondents' level of capability in librarianship when grouped according to length of service ($F = 3.101$; $p = 0.033 < 0.05$). In addition, there was a significant relationship between respondents' attitude and level of involvement in librarianship as shown by r value of 0.520 (moderate correlation) and the p -value of 0.000, which is less than the 0.01 level of significance. Also there was a significant relationship between respondents' level of involvement and level of capability in librarianship as shown by r value of 0.638 (moderate correlation) and the p -value of 0.000, which is less than the 0.01 level of significance. The research study concluded that the more positive the attitude of the respondents toward librarianship, the higher their level of involvement in it. The higher the level of involvement in librarianship, the higher the level of capability in it. This further suggests that the more actively engaged someone is in the field of librarianship (involvement), the more knowledgeable they become.

Keywords: attitude, involvement, capability, BICOL, librarians, librarianship

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Introduction

In a post by Pekoll (2019), Dr. Ranganathan argued that library organizations must accommodate growth in staff, the physical collection, and patron use. This involved allowing for growth in the physical building, reading areas, shelving, and in space for the catalog. This statement emphasizes the dynamic character of libraries and places librarians in the role as guardians of this living institution. Customers' faith in librarians is mostly based on their perception of their legitimacy, which is reflected in their opinions about their work. Positive attitudes among librarians directly affect customer satisfaction, as stated by Smith and Jones (2018), providing a solid basis for efficient library services. Accurate information dissemination is at the core of librarianship, demanding an inherent commitment to precision and reliability.

The fact that librarians are involved in keeping up with emerging trends and industry best practices guarantees the accuracy of the information they offer. According to Johnson et al. (2020), librarians play a critical role in extending the reach of the library and guaranteeing the accuracy of information customized to meet the requirements of a varied community. They emphasize the importance of librarians' involvement in community outreach activities.

Hence, this study investigates the attitude, involvement and capability in librarianship among librarians in the region. This research would provide them with new insights and opportunities regarding the attitudes, involvement, and capabilities towards librarianship within the Bicol Region, both for current practitioners and future users. It also offers an understanding of the challenges faced in daily library operations across various aspects, providing valuable knowledge of the region's librarianship landscape.

Literature Review

Pereira et al. (2021b) finds that a school library does not, in general, present itself as an inclusive and accessible space, and as a result, it is not a part of the deaf community's life. Additionally, the way mediators treat deaf children does not enhance their sense of belonging or their ability to appropriate different literary texts. It comes to the conclusion that picture books, with their visually responsive language, help deaf children integrate into the world of reading and promote delight, pleasure, and education through literature.

Poole (2020) argues that information specialists and librarians have utilized their expertise to support businesses in the private sector in going online and maintaining operations. How the epidemic will ultimately alter our routines, viewpoints, and actions is yet unknown.

Many implications for professional practice emerged from an examination of the information and attitudes that guided public librarians' contacts with clients who were experiencing a crisis. These implications centered on examining and recognizing the ways in which attitudes are formed, changed, and revised via experience and training. A lack of information, "not knowing what to do," or a misunderstanding of what success meant were closely associated with many of the participant attitudes that were shown in the training-related outcomes. Uncertainty about how to connect with a patron and judging whether one was effective in helping a patron in crisis was linked to feelings of vulnerability, a desire to remain nonjudgmental, and a commitment to treating patrons equitably regardless of their circumstances (Williams and Ogden, 2020).

Among the difficulties mentioned are the disastrous results of the detrimental effects of the workplace, culture, and stylistic criteria, such as concept, attitude, and obstacles from the professional world. The overwhelming influence of team policies and procedures, taking advantage of the weaker members, a lack of understanding and justification for the collaboration, members' resistance to change, a lack of socialization, the size of the group, incorrect membership, and discarding of ideas are some of the factors that ultimately lead some members to decide to leave the team. The study suggests that different stakeholders in LIS education and training collaborate across disciplines, within institutions, and across institutions (Enakrire et al., 2020b).

According to Lundstrom et al. (2021b), the key to these kinds of circumstances is their erratic nature. If a teaching schedule that is only occasionally possible due to a liaison model or other framework, the assistance needed to help that person become a better teacher or effectively manage the anxiety that results will probably not be worth the expense. Why invest hours in support and training scenarios for an infrequent occurrence? But in actuality, it's possible that the infrequent teaching opportunity is significantly affecting that person's attitude toward the organizational structures that force them to teach, their perception of their profession, and their home/life balance.

It is not advisable to set expectations for librarians' time on task because the average librarian participating on systematic review teams has little prior experience and because times can vary greatly depending on assigned roles, duties, years of experience, and complexity of research question. This could be the reason why library managers find it challenging to plan ahead and assign staff time to systematic review initiatives, as well as why they have differing expectations regarding librarians' participation in these reviews. Librarian supervisors and library directors who plan to have staff members provide systematic review services should endeavor to gain a thorough understanding of the procedures involved in conducting and evaluating systematic reviews, even though it might not be feasible to establish clear guidelines for the amount of time librarians should spend on these tasks to more accurately calculate time commitments (Bullers et al., 2018).

According to Gross et al. (2022b), explains that not participating in professional bodies like the ACRL and/or the ACRL Community and Junior College Libraries Section (CJCLS) is another explanation offered for not adopting the Framework. One respondent stated that the Framework is not being used "for no particular reason," and another reason cited for not using it in ILI was the pandemic shutdown.

In order for librarians to be included in strategy planning, connected to pertinent campus groups, and supported in tenure and promotion when applicable, non-librarian professors and administrators must view librarians as educational partners. Additionally, they must provide feedback to library and information science departments who are creating curricula for the upcoming class of students. Each of these factors has bearing on the profession, the local library environment, and the practice of librarianship by an individual. A person needs to consider how they come across in reference interactions or while making a presentation to college administration. It is imperative for a library to establish its brand on campus, encompassing the perception of its librarians. Professional associations need to speak out in favor of laws and programs that advance the field of emerging challenges (Fagan et al., 2019).

Librarians possess a variety of talents, including technical proficiency, knowledge of information literacy, and flexibility in response to emerging technologies (Rodriguez et al.,

2023). Studies by Brown and Garcia (2021) demonstrate how important it is for librarians to continue their professional development in order to improve their skills. Still, there is a lack of research on the particular skills that librarians in the Bicol Region possess, which calls for a targeted analysis to pinpoint areas that require assistance and development.

Although the study's purpose was to shed light on a specific group of librarians' research capacities, academic librarians in general may find value in the study's findings as many of them, whether or not they are on the tenure track, conduct research. The data indicates that time—both for reading research articles and for doing research—as well as confidence in particular processes in the research process appear to be the main obstacles facing librarians (Kennedy & Brancolini, 2018).

The impact of the industrial era 4.0 influential in various fields of work are no exception librarians. Librarian is someone who has the ability and expertise librarianship the librarians in charge to prepare themselves to face the era that is the way to equip themselves with information technology and analytical capabilities of the library so that airport users effective (Hayani et al., 2021b).

The necessity for race-based data standards in healthcare, the power of information services to influence or engage in authorship and publication to remedy gaps, and the possibility of eliminating systemic racism in collecting policies are among the opportunities that have been recognized. The results are synthesized using a framework of CRT tenets, which highlights the applicability and usefulness of CRT as a tool for pursuing fairness in scholarship, education, and information practice (O'Driscoll & Bawden, 2022b).

The significance of establishing inclusive and accessible library settings is emphasized by Pereira et al. (2021b), especially for marginalized communities like the deaf. With their visually captivating content, picture books are essential for helping deaf youngsters integrate and become literacy ready. Poole (2020) highlights the flexibility of librarians in assisting companies with their shift to digital platforms within the pandemic, underscoring the dynamic character of librarianship in reaction to new situations.

A broad range of abilities, from technical competency to information literacy understanding, are possessed by librarians. But in order to pinpoint areas that require development, especially for librarians in the Bicol Region, focused analysis is necessary (Brown & Garcia, 2021).

Methodology

The population of this study was composed of 250 member librarians of the Bicol Regional Librarians Council in different provinces and libraries in the Bicol Region. Using the Raosoft calculator with a 10% margin of error and 95% confidence level, a sample size of 70 respondents was taken. Actual selection of the respondents was be done using simple random sampling.

Furthermore, content validity was determined using Cronbach's Alpha Coefficient. For attitude: 0.796 (good reliability index), for involvement: 0.832 (acceptable reliability index) and for capability: 0.922 (excellent reliability index).

Results and Discussion

Table 1 presents the demographic profile of the respondents.

Table 1
Respondents' Demographic Profile

Profile		Frequency	Percentage
Age	Under 25	5	7.1
	25–34	25	35.7
	35–44	21	30
	45–54	8	11.4
	55 and above	11	15.7
Gender	Male	5	7.1
	Female	65	92.9
Educational attainment	Bachelor's degree	28	40
	Master's degree	41	58.6
	Doctorate degree	1	1.4
Length of service (in years)	Less than 1	4	5.7
	1–5	19	27.1
	6–10	15	21.4
	More than 10	32	45.7
Total number of respondents: 70			

As seen in the table, out of the 70 respondents, 25 or 35.7 percent were aged 25–34; 21 or 30.00 percent belonged to 35–44 age bracket; 11 or 15.7 percent were 55 years of age and above; 8 or 11.4 percent were 45 to 54 years old, and 5 or 7.1 percent were under 25 years of age. As to gender, 65 or 92.9 percent were female and 5 or 7.10 percent were male.

As to educational attainment, 41 or 58.60 percent of the respondents had master's degree; 28 or 40.00 percent had bachelor's degree; and 1 or 1.40 percent had a doctorate degree. As to length of service, 32 or 45.70 percent of the respondents had been in service for more than 10 years; 19 or 27.20 percent for 1 to 5 years; 15 or 21.40 percent for 6 to 10 years; and 4 or 5.70 percent had been in service for less than a year.

Table 2 presents the respondents' attitude towards librarianship.

Table 2*Respondents' Attitude Towards Librarianship*

Indicator	Weighted Mean	Verbal Interpretation	Rank
1. They find work as a librarian to be personally fulfilling and meaningful	3.79	(Strongly Agree) Very Positive	4
2. They believe librarianship is a valuable and respected profession.	3.93	(Strongly Agree) Very Positive	2
3. They are confident in its ability to meet the information needs of my patrons.	3.71	(Strongly Agree) Very Positive	6
4. They feel challenged and stimulated by the constant changes and innovations in the library field.	3.70	(Strongly Agree) Very Positive	7
5. They would recommend librarianship as a career path to others	3.83	(Strongly Agree) Very Positive	3
6. They feel adequately supported by the library administration in its professional development	3.44	(Strongly Agree) Very Positive	10
7. They believe that librarians play a crucial role in promoting information literacy and critical thinking skills.	3.94	(Strongly Agree) Very Positive	1
8. The public perception of librarianship accurately reflects the diverse responsibilities and expertise of the profession.	3.54	(Strongly Agree) Very Positive	8
9. They are concerned about the future of librarianship in the digital age.	3.46	(Strongly Agree) Very Positive	9
10. They are satisfied with the career choice as a librarian.	3.77	(Strongly Agree) Very Positive	5
Average	3.71	(Strongly Agree) Very Positive	

To sum up, the respondents had a “very positive” attitude towards librarianship with an average weighted mean of 3.71. Someone with a very positive attitude towards librarianship is likely to be a highly motivated and effective librarian. They would also be a great advocate for libraries, promoting their value to the community.

Table 3 presents the respondents' level of involvement in librarianship.

Table 3*Level of Involvement of the Respondents in Librarianship*

Indicator	Weighted Mean	Verbal Interpretation	Rank
1. They actively participate in professional development opportunities related to librarianship.	3.61	(Strongly Agree) Very High	4
2. They regularly attend conferences, workshops, or webinars related to library science.	3.31	(Strongly Agree) Very High	9
3. They are involved in professional organizations or associations for librarians.	3.53	(Strongly Agree) Very High	7
4. They contribute to the field by volunteering my time or expertise to library-related initiatives.	3.30	(Strongly Agree) Very High	10
5. They stay up-to-date on current trends and issues impacting libraries and librarianship.	3.51	(Strongly Agree) Very High	8
6. They regularly share knowledge and resources with colleagues within the library field.	3.59	(Strongly Agree) Very High	6
7. They advocate for the importance of libraries and librarians to the public and policymakers.	3.60	(Strongly Agree) Very High	5
8. They feel a sense of responsibility to contribute to the advancement of the library profession.	3.76	(Strongly Agree) Very High	2
9. They believe involvement in librarianship makes a difference in the communities I serve.	3.77	(Strongly Agree) Very High	1
10. They feel fulfilled and professionally satisfied by my role in contributing to the field of librarianship.	3.71	(Strongly Agree) Very High	3
Average	3.57	(Strongly Agree) Very High	

To sum up, the respondents had a “very high” level of involvement in librarianship with an average weighted mean of 3.57. A very high level of involvement goes beyond simply performing daily tasks well. It is about actively shaping the future of the profession and making a lasting impact.

Table 4 presents the respondents’ level of capability in librarianship.

Table 4
Respondents' Level of Capability in Librarianship

Indicator	Weighted Mean	Verbal Interpretation	Rank
1. They are confident in the ability to find information on a variety of topics using various information resources.	3.71	(Strongly Agree) Very High	1
2. They are comfortable using library databases, cataloging software, and other relevant technology tools.	3.54	(Strongly Agree) Very High	7.5
3. They possess strong communication skills, allowing me to effectively explain information and research strategies to patrons.	3.54	(Strongly Agree) Very High	7.5
4. They are confident in the ability to create engaging programs and events to serve the needs of the library community.	3.50	(Strongly Agree) Very High	9.5
5. They are comfortable staying up-to-date with the latest trends and technologies in the field of librarianship.	3.60	(Strongly Agree) Very High	5
6. They feel confident in the ability to critically evaluate information sources and assess their credibility.	3.50	(Strongly Agree) Very High	9.5
7. They are comfortable working independently and managing time effectively to complete various library tasks.	3.70	(Strongly Agree) Very High	2.5
8. They are comfortable collaborating with colleagues and other professionals to achieve shared goals.	3.67	(Strongly Agree) Very High	4
9. They believe they possess the necessary skills to effectively advocate for the library and its services within the community	3.56	(Strongly Agree) Very High	6
10. They feel confident in the ability to adapt to new situations and challenges that may arise in the library environment.	3.70	(Strongly Agree) Very High	2.5
Average	3.60	(Strongly Agree) Very High	

To sum up, the respondents had a “very high” level of capability in librarianship with an average weighted mean of 3.60. Librarians with a very high level of capability are likely to be leaders in the profession, inspiring colleagues and continuously improving library services.

Table 5 presents the difference in the respondents' attitude towards librarianship when grouped according to profile variables.

Table 5

Difference in the Respondents' Attitude Towards Librarianship When Grouped According to Profile Variables

Profile	Test statistic	p-value	Interpretation
Age	(F-test) F = 1.333	0.267	Not Significant
Gender	(t-test) t = -1.107	0.272	Not Significant
Educational attainment	(Kruskal-Wallis test) $\chi^2 = 3.181$	0.204	Not Significant
Length of service	F = 0.468	0.705	Not Significant
Significance level at 0.05			

As reflected in the table, there was no significant difference in the respondents' attitude towards librarianship when grouped according to age ($F = 1.333$, $p = 0.267 > 0.05$), gender ($t = -1.107$; $p = .272 > 0.05$), educational attainment ($\chi^2 = 3.181$; $p = .204 > 0.05$), and length of service ($F = 0.468$; $p = .705 > 0.05$). This means that regardless of the profile variables, the respondents had similar attitude towards librarianship, which was very positive.

Table 6 presents the difference in the respondents' level of involvement in librarianship when grouped according to profile variables.

Table 6

Difference in the Respondents' Level of Involvement in Librarianship When Grouped According to Profile Variables

Profile	Test statistic	p-value	Interpretation
Age	(F-test) F = 2.449	0.055	Not Significant
Gender	(t-test) t = -0.324	0.747	Not Significant
Educational attainment	(Kruskal-Wallis test) $\chi_{BD}^2 = 3.39$ $\chi_{MD}^2 = 3.69$ $\chi_{DD}^2 = 3.80$ $\chi^2 = 12.440$	0.002*	Significant
Length service	F=01.611	0.195	Not Significant
*Significant at 0.05			

As indicated in the table, there was no significant difference in the respondents' level of involvement in librarianship to age ($F = 2.449$, $p = 0.055 > 0.05$), gender ($t = 0.324$, $p = 0.747 > 0.05$), and length of service ($F = 01.611$, $p = 0.195 > 0.05$). This means that regardless of age, gender, and years in service, the respondents' level of involvement in librarianship was the same, which was very high.

However, there was a significant difference in the respondents' level of involvement in librarianship when grouped according to educational attainment ($\chi^2 = 12.440$; $p = 0.002 < 0.05$). This means that the librarian with a doctoral degree ($\chi_{DD}^2 = 3.80$) had a higher level of involvement in librarianship than those with either a master's degree ($\chi_{MD}^2 = 3.69$) or a

bachelor's degree ($x_{BD} = 3.39$). Further, the librarians with a master's degree ($x_{MD} = 3.69$) had a higher level of involvement in librarianship than those with a bachelor's degree ($x_{BD} = 3.39$).

Table 7 presents the difference in the respondents' level of capability in librarianship when grouped according to profile variables.

Table 7

Difference in the Respondents' Level of Capability in Librarianship When Grouped According to Profile Variables

Profile	Test statistic	p-value	Interpretation
Age	(F-test) $F = 0.658$	0.624	Not Significant
Gender	(t-test) $t = 0.208$	0.836	Not Significant
Educational attainment	(Kruskal-Wallis test) $x^2 = 2.926$	0.232	Not Significant
Length of service	$X_1 = 3.08$ $X_2 = 3.68$ $X_3 = 3.52$ $X_4 = 3.66$ $F = 3.101$	0.033*	Significant (Between 1&2, 1&4)
*Significant at 0.05			

As gleaned from the table, there was no significant difference in the respondents' level of capability in librarianship when grouped according to age ($F = 0.658$, $p = 0.624 > 0.05$), gender ($t = 0.208$; $p = .836 > 0.05$), and educational attainment ($x^2 = 2.926$; $p = .232 > 0.05$). This means that regardless of the profile variables, the respondents had similar level of capability in librarianship, which was very high.

However, there was a significant difference in the respondents' level of capability in librarianship when grouped according to length of service ($F = 3.101$; $p = 0.033 < 0.05$). This means that the librarians who had been in service for 1–5 years ($X_2 = 3.68$) had a higher level of capability in librarianship than the rest of the groups. Librarians who had been in service for more than 10 years ($X_4 = 3.66$) had a higher level of capability than those who had been in service for 6–10 years ($X_3 = 3.52$) and less than 1 year ($X_1 = 3.08$). Librarians who had been in service for 6 to 10 years ($X_3 = 3.52$) had a higher level of capability than those who had been in service for less than a year ($X_1 = 3.08$).

Table 8 presents the relationship between the respondents' level of attitude and level of involvement in librarianship.

Table 8

Significant Relationship Between the Respondents' Attitude and Level of Involvement in Librarianship

	Pearson r value	p-value	Interpretation
The Respondents' Attitude and Level of Involvement in Librarianship	0.520 Moderate correlation	0.000**	Significant
**Significant at 0.01			

As shown in the table, there was a significant relationship respondents' attitude and level of involvement in librarianship as shown by r value of 0.520 (moderate correlation) and the p-value of 0.000, which less than the 0.01 level of significance. This means that the more positive the attitude of the respondents toward librarianship, the higher their level of involvement in it.

Table 9 presents the relationship between the respondents' level of involvement and level of capability in librarianship.

As reflected in the table, there was a significant relationship respondents' level of involvement and level of capability in librarianship as shown by r value of 0.638 (moderate correlation) and the p-value of 0.000, which less than the 0.01 level of significance. This means that the higher the level of involvement in librarianship, the higher the level of capability in it.

Table 9

Significant Relationship Between the Respondents' Level of Involvement and Level of Capability in Librarianship

	Pearson r value	p-value	Interpretation
The Respondents' level of involvement and Level of capability in Librarianship	0.638 Moderate correlation	0.000**	Significant
**Significant at 0.01			

Conclusion

This study tested the null hypotheses that a) there is no significant difference in the respondents' level of attitude towards librarianship when grouped according to profile variables; b) there is no significant difference in the respondents' level of involvement in librarianship when grouped according to profile variables, c) there is no significant difference in the respondents' level of capability in librarianship when grouped according to profile variables; d) there is no significant relationship between the respondents' level of attitude and level of involvement in librarianship; and e) there is no significant relationship between the respondents' level of involvement and level of capability in librarianship.

Out of the 70 librarian-respondents, 25 or 35.7 percent were aged 25–34; 65 or 92.9 percent were female; 41 or 58.60 percent of the respondents had master's degree; 32 or 45.70 percent of the respondents had been in service for more than 10 years. The librarians had a “very positive” attitude towards librarianship with an average weighted mean of 3.71. They also had a “very high” level of involvement in librarianship with an average weighted mean of 3.57.

Also, librarians had a “very high” level of capability in librarianship with an average weighted mean of 3.60. And there was no significant difference in the respondents' attitude towards

librarianship when grouped according to age ($F = 1.333$, $p = 0.267 > 0.05$), gender ($t = -1.107$; $p = .272 > 0.05$), educational attainment ($\chi^2 = 3.181$; $p = .204 > 0.05$), and length of service ($F = 0.468$; $p = .705 > 0.05$).

There was also no significant difference in the respondents' level of involvement in librarianship to age ($F = 2.449$, $p = 0.055 > 0.05$), gender ($t = 0.324$, $p = 0.747 > 0.05$), and length of service ($F = 0.1611$, $p = 0.195 > 0.05$). However, there was a significant difference in the respondents' level of involvement in librarianship when grouped according to educational attainment ($\chi^2 = 12.440$; $p = 0.002 < 0.05$). And there was no significant difference in the respondents' level of capability in librarianship when grouped according to age ($F = 0.658$, $p = 0.624 > 0.05$), gender ($t = 0.208$; $p = .836 > 0.05$), and educational attainment ($\chi^2 = 2.926$; $p = .232 > 0.05$). However, there was a significant difference in the respondents' level of capability in librarianship when grouped according to length of service ($F = 3.101$; $p = 0.033 < 0.05$). There was a significant relationship respondents' attitude and level of involvement in librarianship as shown by r value of 0.520 (moderate correlation) and the p -value of 0.000, which less than the 0.01 level of significance.

But there was a significant relationship respondents' level of involvement and level of capability in librarianship as shown by r value of 0.638 (moderate correlation) and the p -value of 0.000, which less than the 0.01 level of significance.

Libraries in the Bicol region may tailor their training support and resources to meet the varied requirements of aspiring librarians in all areas of the library profession. Institutions would be well-advised to invest in enrolling librarians to pursue advanced studies, particularly those from librarians with less than a year of service and those aged under 25 years old. Furthermore, recognizing the unbalanced gender distribution which is unfavorable to the male population highlights the significance of inclusivity in survey participation, promoting an increase in marketing the profession which could be attractive to the male demographic.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

AI-assisted technologies used in this paper include replacement of vague and confusing words to provide better choices to provide clarity and to paragraphs. Also used for proofreading and checking for references to narrow the plagiarized statements for the full authenticity of this study.

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Can Japan Learn From Hawai‘i for Its Multicultural Future? An Analytical Journey From Multicultural Hybridity to Multicultural Complexity

Mitsuko Takei, Hiroshima Shudo University, Japan
Kenta Babasaki, Hiroshima Shudo University, Japan

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Abstract

Japan is undergoing rapid demographic change as both the number and diversity of foreign residents increase, prompting policy responses framed through *tabunka kyōsei* (multicultural coexistence), a framework that emphasizes harmonious living and pragmatic accommodation of cultural and linguistic diversity. Despite its prominence, *tabunka kyōsei* has been widely criticized for lack of conceptual coherence and uneven institutional implementation. Against this backdrop, this study poses the guiding research question: Can Japan learn from Hawai‘i in shaping its multicultural future? Rather than assessing policy effectiveness or advocating policy transfer, the study adopts an analytical approach by developing a conceptual framework that contrasts multicultural hybridity with multicultural complexity. Drawing on a qualitative synthesis of interdisciplinary literature, the paper examines how Hawai‘i’s historically grounded hybridity has become normalized through everyday practices such as language use, foodways, and education, while remaining entangled with structural inequality and colonial legacies. By contrast, Japan’s contemporary multicultural condition is characterized as complex, marked by the coexistence of inclusive policy discourse, persistent narratives of homogeneity, and managed policy-driven interventions such as Plain Japanese (*yasashii nihongo*). The paper argues that Japan can “learn from Hawai‘i” not by emulating its social formations, but by using comparison to clarify how diversity is configured, experienced, and institutionalized in different contexts. The hybridity-complexity lens thus offers a context-sensitive analytical tool for rethinking multiculturalism and informing higher education practices that foster reflective engagement with diversity in contemporary Japan.

Keywords: multiculturalism, hybridity, complexity, higher education

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Introduction

Japan is undergoing significant demographic transformation as the number of foreign residents continues to rise. In response to this shift, national and local governments have sought to establish institutional frameworks to accommodate increasing cultural and linguistic diversity in Japanese society. The most prominent of these frameworks is *tabunka kyōsei* (multicultural coexistence), which promotes harmonious living among people from diverse cultural backgrounds and has functioned as a guiding policy concept since the mid-2000s.

The Ministry of Internal Affairs and Communications (MIC) first articulated *tabunka kyōsei* as a policy objective in its 2006 report, defining it as the creation of local communities in which individuals of diverse nationalities coexist, recognize cultural differences, and build mutually respectful relationships. The report emphasized pragmatic measures, including the provision of multilingual information, support for daily living activities, and initiatives aimed at fostering mutual understanding at the community level (MIC, 2006).

Building on this foundation, subsequent policy developments expanded this framework. The MIC's 2020 report reaffirmed *tabunka kyōsei* as a central response to ongoing demographic change, highlighting the growing diversification of foreign resident populations in terms of nationality, length of stay, and social background. The report further underscored the need for enhanced collaboration among local governments, educational institutions, and community organizations as well as the development of more comprehensive support systems addressing language, education, employment, and disaster preparedness (MIC, 2020).

Taken together, the 2006 and 2020 MIC reports position *tabunka kyōsei* as both a normative ideal and an administrative framework for managing diversity in Japan. At the same time, the increasing complexity of migration patterns raises questions about how multicultural coexistence is interpreted and enacted in everyday contexts, as well as which analytical perspectives are most effective for examining these processes.

This study addresses these questions through a comparative lens, using Hawai'i as a point of reference. Rather than evaluating policy effectiveness or advocating policy transfer, this study poses a broader analytical question: Can Japan learn from Hawai'i in shaping its multicultural future and, if so, how? By placing Japan's *tabunka kyōsei* framework alongside Hawai'i's historically grounded multicultural practices, this study seeks to clarify what such a comparison reveals about Japan's evolving multicultural condition. To address this objective, this study outlines its methodology, synthesizes relevant literature, and develops a hybridity-complexity framework for analysis.

Methodology

This paper constitutes the first stage of a multistage research project that aims to develop a higher education curriculum in Japan designed to foster intercultural competence and readiness for diversity through an understanding of multicultural realities. At this initial stage, the study employed a qualitative, conceptual, and comparative research design grounded in a systematic literature review. Rather than collecting primary empirical data, the study synthesized journal articles, academic monographs, edited volumes, government policy documents, and educational research reports relevant to multiculturalism in Hawai'i and Japan.

The reviewed literature was organized into four analytical domains: (1) theoretical foundations of multiculturalism and cultural identity; (2) sociological and educational studies of Hawai‘i; (3) policy and discourse analyses of Japan’s *tabunka kyōsei*; and (4) educational research on multicultural and intercultural learning. The first domain provided conceptual tools for understanding diversity, negotiation, and coexistence; the second illuminated how multicultural practices in Hawai‘i have developed historically and are enacted in everyday life; the third examined how multicultural coexistence in Japan has been framed and implemented institutionally; and the fourth enabled comparative analysis of pedagogical debates, particularly in higher education.

This study does not seek to rank societies or evaluate policy effectiveness. Instead, comparison is employed as an analytical tool to illuminate differing configurations of multicultural life. Although limited by its reliance on existing literature, this approach enables a broad interdisciplinary synthesis that informs the subsequent empirical and curricular stages of the project.

Synthesis of Key Literature

Theoretical Foundations

Foundational scholarship in cultural and postcolonial theory challenges the notion of fixed or essentialized cultural identity. Hall (1992) argues that cultural diversity is not static but is continuously formed through historical, social, and political processes, emphasizing its dynamic and contested nature. Bhabha’s (1994) concept of hybridity introduces the notion of a “third space,” in which cultural meanings are negotiated through interaction. In later work, Bhabha (2011) revisited the idea of “in-between” spaces, further elaborating hybridity as an ongoing process of negotiation in identity formation. Vertovec (2007) proposed the concept of super-diversity to capture the complex interplay of ethnicity, migration status, and social differentiation in contemporary societies. Kymlicka (2010) reviewed global debates on multiculturalism, noting both its normative achievements and the growing body of criticism directed towards it.

Hawai‘i: Normalized Hybridity and Structural Inequality

Sociological and educational research characterizes Hawai‘i as a society shaped by the indigenous presence, colonial histories, and successive waves of multiethnic immigration (McDermott & Andrade, 2011). Within this context, cultural and linguistic hybridity has emerged not as an abstract ideal but through everyday practices embedded in work, schooling, and social interaction.

Linguistic scholarship has been particularly influential in illustrating how hybridity operates in everyday life of Hawai‘i. Hawai‘i Creole English, commonly referred to as Pidgin, emerged from sustained contact among speakers of different languages in plantation settings where no single group’s language held dominance (Sakoda & Siegel, 2003). Over time, Pidgin developed into a stable, rule-governed creole that functioned as a shared communicative resource across ethnic lines. Importantly, Pidgin is not merely a linguistic mixture but a socially meaningful practice that indexes local identity, solidarity, and belonging. Its use signals participation in a shared social space shaped by historical labor relations, migration, and everyday interactions. While Standard English retains institutional authority in formal domains such as schooling and governance, Pidgin circulates widely in informal and semi-formal contexts, illustrating the

coexistence of multiple linguistic norms within a single society. This plural linguistic regime demonstrates how hybridity becomes normalized through repeated relational use rather than formal policy intervention.

Foodways provide a parallel lens for understanding how cultural hybridity is produced and sustained in Hawai‘i. Studies of local cuisine trace the emergence of hybrid dishes, such as *saimin* and plate lunches, to the everyday realities of multiethnic labor and shared living conditions (Hobart, 2018). These foodways emerged through practical cooperation, resource sharing, and adaptation, rather than deliberate cultural preservation or integration policies. Thus, foodways embody hybridity as a lived process rooted in necessity and social interaction. Food practices in Hawai‘i function as sites where cultural memories, migration histories, and social relationships intersect, rendering hybridity visible and tangible in everyday life. Moreover, these foodways circulate across generations and communities, reinforcing a shared sense of local identity while simultaneously reflecting unequal histories of labor, race, and class. In educational and community settings, food is frequently employed as an entry point for discussing history and identity, thereby further embedding hybridity within both informal and formal learning contexts.

Educational research further underscores the role of local institutions in sustaining and transmitting hybridity. Culture-based and place-based educational approaches in Hawai‘i emphasize learning grounded in local history, language, and community knowledge, particularly in relation to Native Hawaiian experiences (Kana‘iaupuni et al., 2010, 2014). These approaches highlight how education functions not only as a site of knowledge transmission but also as a space in which cultural meanings, identities, and historical relationships are actively negotiated. In this sense, hybridity in Hawai‘i is reinforced through educational practices that recognize multiplicity and relationality as everyday social realities.

At the same time, scholars caution against romanticizing Hawai‘i’s multicultural image. Research consistently documents the persistence of structural inequality, racialized stratification, and unresolved colonial legacies beneath narratives of harmony and inclusiveness (Mossakowski & Wongkaren, 2016; Okamura, 2008; Trask, 1999). Studies of Japanese American experiences further demonstrate that hybridity is not a completed outcome but an ongoing, generationally negotiated process shaped by shifting power relations and social positioning (Okamura, 2014).

In sum, the literature characterizes Hawai‘i as a context in which multicultural hybridity is normalized through everyday social and educational practice while remaining inseparable from historical injustice and unequal power structures. From this perspective, hybridity does not resolve inequality but instead coexists with it, offering a relational and historically grounded configuration of diversity that provides an important analytical contrast to policy-managed multiculturalism elsewhere.

Japan: Multicultural Complexity and *Tabunka Kyōsei*

Since the early 2000s, the concept of *tabunka kyōsei* (multicultural coexistence) has shaped national and local initiatives related to migration, community integration, and education in Japan (Aiden, 2011; MIC, 2006). Emphasizing harmonious coexistence among people of diverse cultural, linguistic, and national backgrounds, *tabunka kyōsei* has become firmly embedded in official policy discourse. However, scholars have repeatedly noted the conceptual ambiguity and its limited capacity to address the structural and institutional dimensions of

diversity (Shiobara, 2020). While policies promoting multicultural coexistence have expanded, everyday practices within educational institutions and local communities remain uneven and fragmented (Gildenhard, 2021). As a result, multiculturalism in Japan is often treated not as a normalized social condition but as a managed response to perceived exceptions, revealing a persistent gap between policy ideals and lived realities. Discourse-oriented studies further demonstrate that *tabunka kyōsei* coexists with enduring narratives of cultural and linguistic homogeneity (Burgess, 2004, 2007), while research on minority experiences highlights tensions between inclusive rhetoric and ongoing marginalization (Chapman, 2006).

Language ideology has played a central role in shaping these dynamics. Heinrich (2012) traces how modern nation-building in Japan has produced an image of linguistic homogeneity, whereas Burgess (2012) demonstrates how proficiency in Japanese functions as a key criterion for belonging and citizenship. Gottlieb's (2012) edited volume illustrates how language policies and everyday linguistic practices mediate access, inclusion, and exclusion within Japanese society. Building on this scholarship, Friedman (2025) shows how multilingual and translational practices can simultaneously expand access while reinforcing institutional boundaries.

Within this context, Plain Japanese (*yasashii nihongo*) has been promoted by local governments, public agencies, and educational institutions as a tool for improving linguistic accessibility for foreign residents and newcomers (Iori, 2016; Iori et al., 2010). By simplifying and regulating expressions, Plain Japanese enables access to information and services within existing institutional frameworks. At the same time, its policy-driven and top-down implementation underscores the managed nature of accessibility in Japan, illustrating how diversity may be accommodated without being fully normalized in everyday social interaction.

Recent scholarship points to gradual shifts toward more pragmatic, immigration- and recognition-based approaches, while emphasizing the uneven, partial, and contested nature of these developments (Ishimatsu, 2025; Liu-Farrer, 2025; Shiobara, 2020).

Taken together, the literature characterizes Japan's multicultural condition as one of *multicultural complexity* shaped by the coexistence of inclusive policy discourse and persistent structural constraints. Although *tabunka kyōsei* has provided an important framework for acknowledging diversity, its implementation remains uneven and largely confined to managed interventions, offering a contrast to contexts of lived hybridity and reinforcing the analytical value of the hybridity-complexity lens.

Educational Perspectives

Educational research across contexts emphasizes reflexivity, critical awareness, and the development of intercultural competence. Intercultural competence frameworks highlight critical cultural awareness, interpretive skills, and attitudes that move beyond surface-level critical knowledge (Byram, 1997; Deardorff, 2006). Banks (2008) situates multicultural education within the broader framework of citizenship education, foregrounding questions of identity, power, and social inclusion. In Japan, scholars have documented both the progress and the structural limitations of multicultural education initiatives operating under *tabunka kyōsei* (Matsuo, 2024; Tokunaga, 2017). Taken together, these educational perspectives provide a pedagogical basis for interpreting processes of hybridization and institutional complexity in higher education contexts.

Discussion

The synthesis of the key literature highlights two distinct yet interconnected configurations of multiculturalism: lived hybridity, as exemplified by Hawai‘i, and multicultural complexity, as exemplified by contemporary Japan. The hybridity-complexity framework developed in this study has important implications for understanding and practicing multicultural and intercultural education. Rather than viewing education as a means to achieve predefined multicultural outcomes, this framework invites reconsideration of the types of learning that are possible and meaningful under different structural conditions of diversity.

At a conceptual level, Hall’s (1992) view of cultural identity as historically produced and continually negotiated, together with Bhabha’s (1994, 2011) notion of hybridity emerging in “third or in-between” spaces, provides a theoretical basis for understanding diversity as relational and dynamic rather than static. Pedagogically, this perspective suggests that learning about diversity cannot be reduced to the acquisition of knowledge about discrete cultural groups. Instead, learning about diversity involves engagement with ambiguity, negotiation, and the historical layering of meanings. The Hawai‘i case, as discussed earlier, illustrates how such hybridity becomes normalized in everyday life while remaining embedded within unequal power relations. For educational practice, this underscores the value of pedagogies that emphasize interpretation and critical contextualization rather than representation alone.

At the same time, Japan illustrates how diversity is often experienced within conditions of multicultural complexity. In such contexts, policy discourse, institutional norms, and language ideologies significantly shape processes of inclusion and exclusion. From this perspective, pedagogical practices do not operate in neutral spaces; rather, they are shaped by the ways in which diversity is institutionally framed and managed. As illustrated by the first author’s previous pedagogical study (Takei, 2025), even preliminary engagement with Hawai‘i’s multicultural history can prompt students to reflect on Japan’s *tabunka kyōsei*. This observation suggests that multicultural learning occurs within managed conditions of diversity rather than outside them. Accordingly, this finding underscores the importance of helping students develop analytical tools for interpreting diversity rather than assuming that experiential exposure alone will generate understanding.

These insights resonate with Byram’s (1997) model of intercultural communicative competence and Deardorff’s (2006) intercultural competence framework, both of which emphasize critical cultural awareness, interpretive skills, and reflective attitudes. Viewed through the lens of hybridity and complexity, these competencies are not conceptualized as individual attributes to be mastered but as relational capacities for navigating diversity as mediated by structural conditions. Intercultural competence, from this perspective, involves learning how identities, language practices, and power relations are produced, negotiated, and constrained within specific institutional contexts.

From a pedagogical standpoint, this study suggested several shifts in emphasis. First, learning activities that encourage comparison across contexts can help students situate their assumptions historically and institutionally. Contrasting Hawai‘i’s lived hybridity with Japan’s managed multiculturalism offers one effective approach to achieving this goal. Second, the preparatory and reflective components of study abroad and internationalization-at-home programs play a mediating role in enabling students to interpret diversity before, during, and after intercultural encounters. Third, attention to linguistic regimes—including emergent forms such as Hawai‘i’s Creole English, and policy-driven forms such as Plain Japanese—provides a concrete entry

point for examining how accessibility, belonging, and power are negotiated through communication.

Importantly, the hybridity-complexity lens does not imply that educational practices should aim to reproduce hybridity or resolve complexity. Rather, it supports pedagogical approaches that enable learners recognize, analyze, and reflect on how diversity is structured and experienced differently across contexts. In this sense, education becomes an arena for interpretive engagement—grounded in theory yet responsive to institutional realities.

Overall, this discussion conceptualizes multicultural education as a meaning-making process situated within structurally conditioned environments by linking the theoretical insights of Hall and Bhabha with the pedagogical frameworks of Byram and Deardorff. Rather than proposing new instructional techniques, this study provides an analytical framework that clarifies the forms of learning that emerge when students engage with contexts characterized by lived hybridity and managed complexity.

Conclusions

This study reconsidered what it might mean for Japan to “learn from Hawai‘i” when envisioning its multicultural future. Rather than positioning Hawai‘i as a model to be emulated or Japan as an example of delayed multiculturalism, the analysis reframed the comparison as a heuristic device for clarifying how diversity is configured, experienced, and institutionalized across sociocultural contexts. By placing multicultural hybridity and complexity in conceptual dialogue, the study underscored the need to move beyond evaluative or normative assessments of multiculturalism toward more context-sensitive analytical frameworks.

Hawai‘i illustrates how cultural and linguistic hybridity can be normalized through everyday practices, sustained relational engagement, and historical processes of migration and intercultural contact. At the same time, critical perspectives emphasize that such normalization coexists with persistent structural inequalities and an unresolved colonial legacy. Japan’s contemporary condition, conceptualized in this study as multicultural complexity, reflects a different configuration of diversity—one in which sociocultural difference is increasingly visible and pragmatically accommodated, yet unevenly institutionalized and symbolically constrained. Taken together, these cases suggest that the central analytical question is not whether a society is multicultural but how diversity is positioned within social, institutional, and educational domains.

This study has several limitations. First, the analysis is primarily conceptual and literature-based, drawing on existing theoretical, sociological, and educational scholarship, rather than original empirical data. While this approach allows for theoretical synthesis and conceptual clarification, it does not capture the full range of the lived experiences of students, educators, and community members in Hawai‘i or Japan. Second, the comparison necessarily simplifies highly diverse and internally differentiated contexts. Hawai‘i and Japan are treated as analytically coherent cases, despite significant variations across regions, institutions, and populations within each context. Third, the discussion of educational implications focuses primarily on higher education and study abroad contexts, leaving other educational levels and informal learning settings for future inquiry.

Despite these limitations, the analytical perspective developed in this study offers a productive foundation for future research. Future studies could extend this work through empirical

classroom-based research, interviews with students and faculty, or longitudinal analyses of curricula and institutional change. Examining how learners interpret and negotiate diversity across educational and community contexts would deepen understanding of how multicultural learning unfolds under conditions of lived hybridity and managed complexity.

In conclusion, Japan can learn from Hawai'i not by becoming like Hawai'i but by using Hawai'i as a comparative reference through which to better understand its own multicultural complexity. Such an understanding is essential for developing educational practices and institutional responses that are analytically robust, contextually responsive, and attentive to the realities of diversity in contemporary Japanese society.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

AI-assisted technologies, including ChatGPT, DeepL, and Grammarly, were used during manuscript preparation for language editing purposes, such as correcting grammatical and spelling errors, improving clarity and readability, and checking for consistency and redundancy. All conceptual and analytical content, interpretations, and conclusions were developed exclusively by the authors.

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Design, Implementation, and Early Engagement Outcomes of a Student-Led AI Tutor in Higher Education

Ahmed Alsharif, Utah Valley University, United States

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Abstract

This paper presents the design, implementation, and assessment of a student-led Artificial Intelligence (AI) tutoring project at Utah Valley University (UVU). The system, integrated within the Canvas Learning Management System, was created to provide real-time, personalized academic support while upholding educational integrity. Its design intentionally modeled the scaffolding practices of human tutors, guiding students through problem-solving rather than supplying direct answers. Development was carried out by a small team of undergraduate students in collaboration with faculty mentors, supported by institutional grants and technology resources. The result was a mobile-friendly, scalable tool capable of supporting multiple courses. A preliminary assessment was carried out during the pilot deployment, drawing on surveys, analytics, and student reflections. Findings showed high engagement, with students reporting that the system enhanced understanding of course content and encouraged active learning. Technical evaluation confirmed reliable performance, and the project demonstrates that student-driven innovations can create meaningful educational technologies that promote accessibility, engagement, and equity in higher education. The findings also highlight both the pedagogical benefits and implementation challenges of introducing AI into authentic classroom contexts, offering a roadmap for institutions seeking to integrate AI responsibly into teaching and learning.

Keywords: generative artificial intelligence, AI tutoring, student engagement, higher education, large language models

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Introduction

Generative AI is now a routine feature of students' academic environment, offering rapid access to explanations, examples, and iterative feedback. Evidence syntheses indicate that generative AI can improve learning performance and learner perceptions on average, but with substantial variability by context, learning design, and the role assigned to the AI tool. This variability implies that "AI in education" does not operate as a uniform intervention; outcomes are design-dependent and sensitive to how the AI is positioned in the learning process (Kasneci et al., 2023; Wang & Fan, 2025).

At the same time, rigorous empirical work cautions that unstructured AI support can undermine durable skill acquisition if students use the tool as a shortcut during practice. A large-scale field experiment in mathematics showed that unfettered access to a "ChatGPT-like" interface improved practice performance but reduced post-access independent performance; safeguards that shift the system toward tutorial hinting rather than answer-giving mitigated these effects (Bastani et al., 2025). This evidence is particularly consequential for higher education, where learning goals emphasize transferable competence and where educational integrity and assessment validity are core institutional responsibilities (Cotton et al., 2024; Kofinas et al., 2025).

The present study reports a student-led AI Tutor integrated into Canvas Learning Management System (LMS). The focus of this paper is deliberately narrow: it emphasizes early engagement outcomes, pedagogical implications, and adoption/implementation lessons, rather than detailed empirical replication of prior reporting. Engagement is treated as a necessary (but not sufficient) condition for learning improvement: if students do not adopt a tutoring system, the system cannot influence persistence, time-on-task, or constructive problem-solving behaviors. Where adoption occurs, the critical design problem is ensuring engagement is *cognitively productive*, not merely frequent use (Chi & Wylie, 2014; Kahu, 2013).

Unlike faculty- or vendor-led AI deployments, this initiative positioned undergraduate students as primary system builders, making the development process itself a form of high-impact pedagogy.

Foundations and Related Work

This project's instructional design rests on the idea that "AI tutoring" should behave like tutoring rather than answer generation. The theoretical basis begins with Vygotsky's (1978) concept of the Zone of Proximal Development which frames learning as what a learner can achieve with appropriate support beyond independent capability. Building on this foundation, Wood et al. (1976) introduced the term "scaffolding" to describe the tutorial supports that enable learners to complete tasks otherwise beyond them, with support that can be withdrawn as competence increases.

Within educational technology research, scaffolding has been operationalized as design patterns that structure learner activity, make thinking visible, and shape inquiry through prompts, templates, and just-in-time feedback. In particular, Quintana et al. (2004) offer a design framework for scaffolded software in science inquiry contexts, emphasizing scaffolds that align with inquiry practices and the challenges learners encounter during those practices. For AI tutoring in an LMS, this body of work supports an important design stance: scaffolding

is not simply “help,” but a mechanism for preserving learner agency and productive struggle while reducing unproductive confusion.

Engagement, in turn, requires careful conceptual definition. Kahu’s (2013) framework in higher education distinguishes engagement as a state arising from interactions among student factors and institutional context, with proximal consequences (e.g., persistence, satisfaction) and distal consequences (e.g., achievement). As a design heuristic, the ICAP (Passive, Active, Constructive, Interactive) framework differentiates Passive, Active, Constructive, and Interactive modes of cognitive engagement, predicting deeper learning as activity shifts toward Constructive and Interactive forms (Chi & Wylie, 2014). For AI tutoring, ICAP implies that “engaging chat” is insufficient; systems should repeatedly elicit learner-generated explanations, intermediate steps, and reciprocal dialogue rather than only delivering polished responses.

Because this paper emphasizes early engagement outcomes, it also draws on HCI (Human–Computer Interaction) measurement work. O’Brien and Toms (2008) define user engagement as a quality of user experience characterized by attention, affect, and endurability, among other attributes. O’Brien et al. (2018) refine engagement measurement through the User Engagement Scale (UES) and short form, providing constructs (e.g., focused attention; perceived usability; endurability) that can inform evaluation design for embedded tutoring interfaces. These constructs are particularly relevant when an AI tutor is integrated into an LMS workflow and adoption depends on both perceived usefulness and a low-friction experience.

Finally, the development model matters for educational innovation. The Students-as-Partners literature conceptualizes learners and staff as collaborators in educational design, emphasizing reciprocity and inclusive partnership practices; systematic review evidence suggests partnerships are frequently small-scale, undergraduate-focused, and oriented toward teaching and learning enhancement (Mercer-Mapstone et al., 2017). This project adopts that orientation by positioning undergraduate developers as co-creators of an authentic learning support system guided by faculty mentorship.

System Design and Implementation

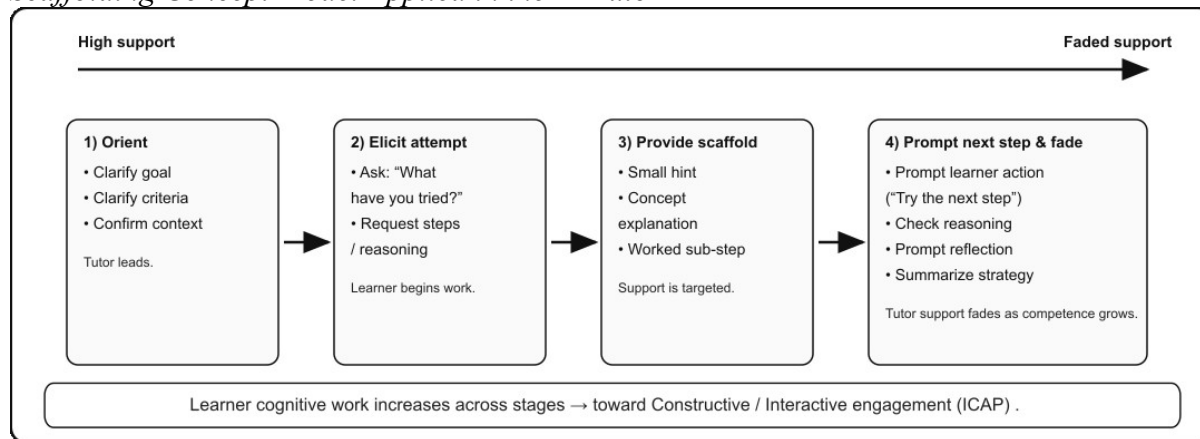
The AI Tutor was implemented as an LMS-embedded tutoring interface within the Canvas LMS intended to reduce help-seeking friction and to keep students within the learning context where questions arise (e.g., assignment pages and course announcements). The system’s instructional goal was not to provide finalized solutions, but to guide students through a scaffolded interaction: clarifying the task, eliciting the student’s attempt, offering hints or concept explanations, and prompting the student to complete the next step. This design choice directly targets the “crutch” risk identified in recent evidence: learners may practice less productively when AI provides direct answers, whereas tutorial hinting can preserve skill learning (Bastani et al., 2025).

Canvas integration choices also shape adoption and governance. In general, LMS-integrated tools frequently rely on the Learning Tools Interoperability (LTI) standard; Canvas documentation describes “external tools” as IMS LTI links and provides configuration and API mechanisms for deploying tools into courses and accounts (Instructure, n.d.). For modern deployments, LTI 1.3 and LTI Advantage leverage the 1EdTech Security Framework. 1EdTech explicitly describes LTI 1.3 as adopting OAuth 2.0 for authentication services, JSON Web Tokens (JWT) for message signing, and the OpenID Connect workflow paradigm, supporting

security and “mobile-ready” interoperability (1EdTech Consortium, n.d.). These standards contextualize institutional choices about safe integration pathways for AI tools operating in learning environments. Figure 1 illustrates the scaffolding conceptual model implemented in the AI Tutor.

Figure 1

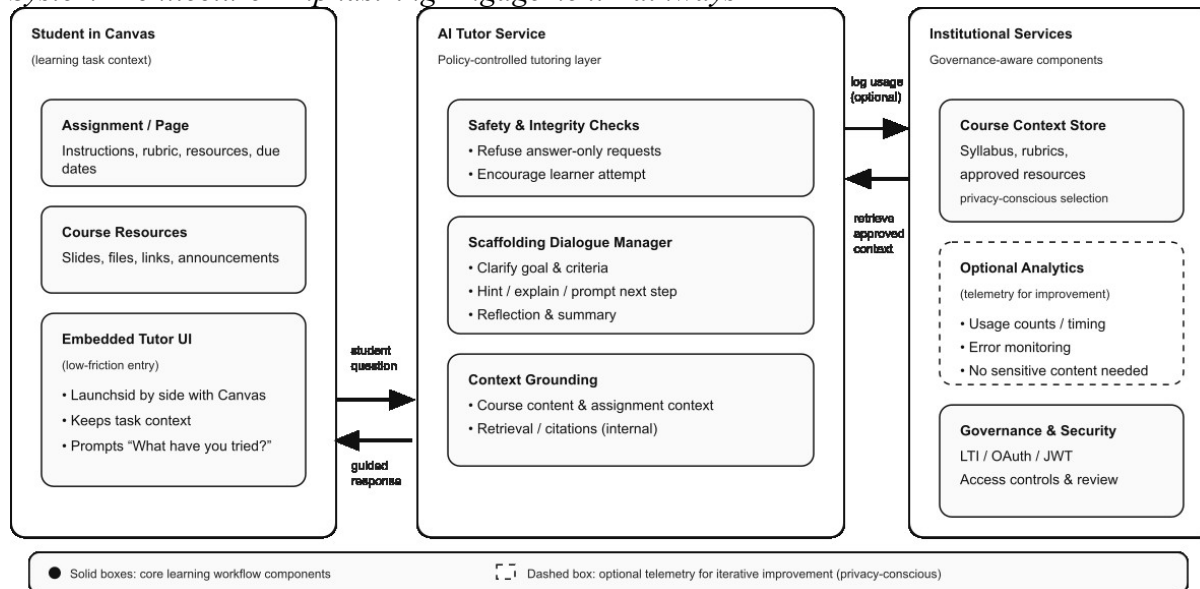
Scaffolding Concept Model Applied in the AI Tutor



Learner behaviors shift toward Constructive/Interactive activity (ICAP), emphasizing that the learner—not the AI—performs the key cognitive work (Chi & Wylie, 2014; Wood et al., 1976). Figure 2 illustrates the system architecture and engagement pathways.

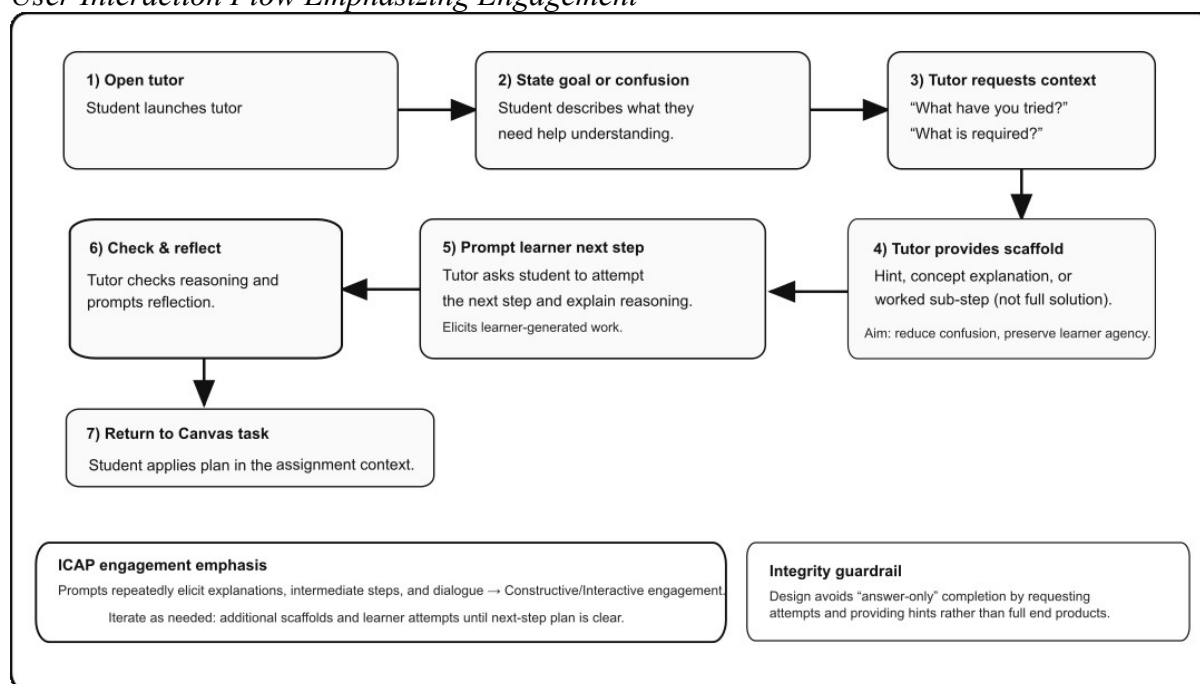
Figure 2

System Architecture Emphasizing Engagement Pathways



This architecture is designed to support engagement by reducing platform switching and by enabling course-contextual relevance, which prior LMS-embedded assistant research identifies as a key driver of satisfaction and engagement when AI assistance is grounded in course content (Mezwri & Turcsányi-Szabó, 2025). Figure 3 illustrates user interaction flow and engagement.

Figure 3
User Interaction Flow Emphasizing Engagement



This flow is explicitly aligned to foster Constructive/Interactive engagement (ICAP) by repeatedly eliciting learner-generated reasoning rather than delivering end products (Chi & Wylie, 2014).

The AI Tutor was developed by a four-member undergraduate team operating under a faculty-mentored, students-as-partners model. Students led the technical implementation, including backend development, interface design, AI integration, and system testing, while the faculty mentor provided pedagogical framing, project governance guidance, and institutional alignment. Development occurred iteratively over approximately one academic year using agile methods, with students responsible for feature prioritization, troubleshooting, and deployment decisions. Beyond producing a functional tutoring system, the project served as an experiential learning environment in which students developed competencies in AI system integration, full-stack development, and interdisciplinary collaboration.

Methods and Data Sources

This exploratory pilot examined early engagement outcomes during the system's initial classroom deployment. The evaluation used mixed evidence sources appropriate for a preliminary engagement study: (a) post-use perception surveys; (b) system usage indicators (as descriptive evidence of adoption); and (c) student reflections capturing how the tutor fit into help-seeking and problem-solving processes.

This pilot was conducted in introductory level course at Utah Valley University during Fall 2025. Of $N = 22$ enrolled students, 17 used the tutor at least once. We collected (a) an end-of-pilot survey, (b) system logs (sessions, messages, timestamps).

Survey constructs were aligned with established engagement measurement perspectives (e.g., attention, perceived usability, and endurability), drawing conceptually from the UES tradition rather than claiming full instrument equivalence (O'Brien et al., 2018).

The analysis focus was intentionally limited to early engagement and instructional fit. The study did not treat engagement perceptions as direct proxies for learning gains, and it did not claim causal inferences due to the absence of experimental controls in the pilot setting. This methodological stance is consistent with engagement theory that distinguishes engagement as a proximal state influenced by context rather than a guaranteed indicator of achievement (Kahu, 2013).

Engagement Findings and Interpretation

Descriptive usage data indicated sustained student interaction with the tutor during the pilot. Average session duration was approximately nine minutes, suggesting multi-turn, inquiry-based dialogue rather than brief transactional use. Survey responses further indicated high perceived usability and engagement, consistent with the system's scaffolding-oriented design. These early indicators support the claim that LMS-embedded AI tutoring can achieve meaningful student adoption when aligned with course context.

Across surveys and reflections, students reported high engagement with the system and described it as helpful for understanding course expectations and content. Students emphasized that guided questioning and stepwise support encouraged “thinking through” problems rather than simply retrieving answers. Interpreted through ICAP, these reports suggest movement toward Constructive/Interactive activity—students generating explanations and responding to iterative prompts—rather than Passive consumption.

These early engagement indicators align with broader findings that educational impact is role-dependent: generative AI tools can support learning and learning perceptions when positioned as structured tutoring aids.

Conclusion, Implications, and Future Directions

This paper presented an engagement-centered account of a student-led AI Tutor integrated into Canvas and designed to operationalize scaffolding as a core tutoring behavior. The project's central pedagogical claim is that engagement benefits depend on design: AI tutoring can increase persistence and usability when embedded in context, but it must be constrained to preserve cognitive work and educational integrity. Recent evidence reinforces that unguarded AI can harm learning outcomes after access is removed, while safeguards that support hinting and guided reasoning mitigate this risk (Bastani et al., 2025).

A secondary contribution of this work is demonstrating that student-led AI development can function as a scalable pedagogical model, not only a technology solution.

Implications for higher education include the need to treat AI tutoring as an instructional design decision rather than a generic technology add-on. Engagement should be evaluated for quality, not only quantity. Institutions also need to pair AI tutoring deployments with integrity guidance and assessment redesign, recognizing evidence that detection and authenticity alone may be insufficient safeguards.

Future work should (a) measure engagement quality more directly (e.g., evidence of learner-generated reasoning in dialogues), (b) test scaffold configurations that explicitly push Constructive/Interactive behaviors, (c) evaluate longer-term learning and transfer under

different guardrail designs, and (d) formalize governance playbooks aligned with institutional privacy and risk frameworks.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the author used Gemini for proofreading and to improve the writing quality. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the final content of the publication.

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Contact email: ahmed.alsharif@uvu.edu

Breaking Barriers: Expanding Science Fair Participation Among Title I Middle and High School Students

Narasimha Shashidhar, Sam Houston State University, United States

Cihan Varol, Sam Houston State University, United States

Amar Rasheed, Sam Houston State University, United States

The IAFOR International Conference on Education in Hawaii 2026

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Abstract

The science fair has long served as a cornerstone of K-12 education, traditionally intended to foster inquiry-driven learning and inspire the next generation of STEM professionals. However, in this paper, we argue that the conventional science fair model, while pedagogically valuable, often perpetuates and amplifies systemic inequities related to socioeconomic status, parental capital, and access to mentorship. These barriers create an uneven playing field that disadvantages students from underserved and marginalized communities, thereby ultimately undermining the science fair's core educational mission. Our analysis explores the systemic challenges inherent in the current format and examines innovative, equity-focused models designed to dismantle these barriers. By incorporating systemic constructs such as university-community partnerships, alternative fair formats, microgrant funding, and the integration of informal learning, we posit that science fairs can be transformed from exclusive competitions into inclusive and effective learning vehicles that unlock the scientific potential of all students. This, we hope, will be an inviting model for STEM engagement among the underserved Title I middle and high school students.

Keywords: science fair, K-12, equity, integration, STEM engagement

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Introduction: The Imperative for Science Fair Reform

The science fair is a long-standing tradition in K-12 STEM education, established as a vital platform for students to engage in inquiry-driven learning, develop critical thinking skills, and cultivate a STEM identity. Its intended purpose is to provide an authentic opportunity for students to ask their own questions, conduct investigations, analyze data, and present their findings, mirroring the practices of professional scientists and engineers. This hands-on experience is designed to move learning beyond the classroom/textbook and into the realm of real-world problem-solving and discovery. Despite this goal, the current landscape of science fairs is fraught with challenges. The current model often reflects and reinforces broader educational inequities, creating significant barriers for students from underserved and marginalized communities. Research reveals that students in Title I and other high-needs schools face obstacles ranging from chronic underfunding, limited teacher support, and a pervasive lack of access to professional mentors. Furthermore, the heavy reliance on parental involvement can inadvertently privilege students from households with higher income and educational attainment, transforming the science fair from a measure of student ingenuity into a reflection of familial resources.

To realize the full potential of science fairs as transformative educational tools, we argue that a paradigm shift is required. To this end, in this paper, we posit that to continue promoting a model that systematically advantages some students while disadvantaging others constitutes a form of educational malpractice in the modern STEM landscape. The educational community must therefore move away from a structure that favors exclusivity and towards one built on intentional, equity-centered design. This reimagined approach necessitates robust mentorship networks, strong community/school partnerships, and innovative formats that lower barriers to entry and broaden participation. We begin this analysis by exploring the pedagogical foundations that make the science fair a valuable educational practice worth preserving and reforming.

The Pedagogical Framework of Science Fairs

To effectively reform the science fair, it is essential to first understand its formal educational value. When implemented effectively, science fairs are a high-impact pedagogical practice that aligns with rigorous academic standards and promotes critical thinking skills essential for success in college and future careers. This section analyzes the strategic alignment of science fair activities with established educational frameworks and their role in familiarizing students with the professional practices of STEM disciplines.

The science fair life cycle which consists of 1. preparation, 2. research, 3. production, 4. presentation, and 5. reflection, provides a natural framework for students to master key competencies outlined in national educational standards. This alignment ensures that participation is not merely an extracurricular activity but a direct application of core curriculum goals. In this section, we outline this alignment using two standards as key examples – Next Generation Science Standards (NGSS) and the Common Core State Standards (CCSS). This clearly does not serve an exhaustive list of comparisons among the myriad standards that exist but merely illustrates our point that science fairs serve a greater purpose than merely an extracurricular activity.

Table 1
Alignment With Educational Standards

Educational Standard	Alignment with Science Fair Activities
Next Generation Science Standards (NGSS)	The science fair life cycle provides a direct pathway for students to engage with the eight essential Science and Engineering Practices (SEPs). These practices include: 1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using critical thinking techniques 6. Constructing explanations and designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information
Common Core State Standards (CCSS)	Science fairs inherently promote key ELA and literacy skills emphasized by the CCSS. The research phase requires students to build knowledge through content-rich study and analysis, and the presentation phase necessitates that their reading, writing, and speaking are grounded in evidence. Specific standards are met when students conduct research, write informative texts describing their procedures, and present their findings coherently.

Beyond meeting specific standards, science fair participation facilitates the process of academic assimilation. This process opens a gateway for students into the professional world of academia and research. As they move through their projects, students become familiar with a wide array of academic terms such as hypothesis, variable, data, analysis, and correlation. These terms are certainly among a few that they will encounter throughout their academic careers. More importantly, they engage in the authentic work of scientists and engineers, which involves reading and interpreting formal texts like journal articles, and producing their own formal and informal communications, from lab notebooks to presentation boards and public speaking.

These pedagogical benefits underscore why science fairs remain a potentially powerful educational tool. However, the realization of these benefits is often impeded by systemic challenges that prevent equitable access and participation, examined in the following section.

Systemic Barriers to Equitable Participation in Science Fairs

Despite their pedagogical promise, traditional science fairs are often structured in ways that create an uneven playing field, particularly for students from high-needs schools and marginalized communities. These events can inadvertently convert a science fair event into showcases of privilege rather than platforms for universal student inquiry. Understanding these systemic barriers related to resources, parental support, and mentorship is the first step toward designing more equitable and inclusive models.

The Foundation of Inequity: Underfunded Schools and Overburdened Teachers

For many schools, particularly those designated as Title I or serving historically poor regions, the fundamental resources required to support a science fair are scarce. This creates a compounding cycle of disadvantages where a lack of financial investment directly leads to logistical and pedagogical shortcomings.

Chronic Underfunding

As noted by Necochea and Cline (1996), schools in underserved communities suffer from chronic underfunding, which limits their ability to purchase essential project materials, access equipment, or provide microgrants to students who cannot afford supplies.

Logistical Challenges

This underfunding is a root cause of the severe logistical difficulties reported by teachers in high-needs schools. According to a study by Lakin et al. (2016), these challenges include finding adequate physical space for the event, recruiting enough qualified judges, and navigating complex competition guidelines.

Limited Teacher Support

The same study found that teachers in high-poverty schools provide less support for student projects. This is not due to a lack of will but is a consequence of systemic pressures, including larger class sizes, fewer resources, and a focus on standardized testing that leaves little time for intensive, project-based work.

The Double-Edged Sword of Parental Involvement

Parental support can be vital to a student's education, but its role in science fairs is complex and often undermines equity. This issue creates a perfect storm of inequity: in the very schools where teacher support is weakest due to systemic constraints (Lakin et al., 2016), the reliance on parental capital is greatest, thereby amplifying disadvantages. Research by Fields et al. (2022) distinguishes between "logistic support" (e.g., purchasing materials) and "substantive support" (e.g., helping choose a research topic or analyze data). The findings reveal a system where access to substantive help is heavily skewed by socioeconomic factors and the availability of social capital.

Key findings from the study reveal a systemic bias wherein:

- While 88% of parents provided logistic support, only 58% provided the more academically involved substantive support.
- A significant correlation exists between higher parental income and the ability to provide substantive support.
- Maternal education is a key factor, with parents holding a bachelor's degree or higher being significantly more likely to provide both logistic and substantive support.

These statistics confirm that a reliance on parental involvement systematically advantages students from higher-income, higher-education households. When project work is expected to happen at home, the science fair becomes a competition of parental capital rather than student merit.

The Mentorship and Cultural Gap

Access to mentors with STEM expertise is crucial for developing ambitious projects, yet this is another area of significant disparity. Necochea and Cline (1996), identify limited access to mentorship as a primary barrier for students in underserved communities, who are less likely to have family or community contacts in STEM fields who can serve as potential mentors. This is compounded by what the body of literature terms “cultural disconnects”, where the traditional structure and expectations of a science fair may not align with the lived experiences and cultural backgrounds of students from diverse populations.

To effectively analyze these multifaceted barriers and later evaluate potential solutions, in this paper, we adopt the five equity frames developed by the National Academies of Sciences, Engineering, and Medicine (NASEM, 2024):

1. Reducing Gaps Between Groups: Addressing disparities in achievement, interest, or representation between different social groups based on factors like race, gender, or social class.
2. Expanding Opportunity and Access: Focusing on ensuring all students have access to the necessary material and social resources to learn, including well-prepared educators, a network of adult and peer supporters, and high-quality curricular experiences.
3. Embracing Heterogeneity: Engaging with the diverse concerns, lived experiences, and identities of students who have been marginalized in STEM, and valuing their different ways of thinking and being.
4. Learning and Using STEM to Promote Justice: Centering STEM as a tool for addressing social and socioecological issues.
5. Sustainable Futures Through STEM: Cultivating equitable and thriving social and ecological futures that support both human and ecological well-being.

To this end, the combination of resource disparities, inequitable parental capital, and a lack of mentorship creates a system that fundamentally violates the NASEM frames of expanding opportunity and access and reducing gaps between groups. This reality necessitates a fundamental reimagining of the science fair model, focusing on intentional strategies to create a truly equitable experience.

Reimagining the Science Fair: Models and Strategies for Equity and Engagement

In response to the systemic barriers of the traditional science fair, educators, researchers, and community partners are developing innovative models and support systems to create more inclusive and engaging experiences. This section shifts from analyzing problems to evaluating solutions, exploring actionable strategies that dismantle inequities and cultivate a richer STEM learning ecosystem for all students.

Cultivating Mentorship and University-Community Partnerships

Closing the mentorship gap identified by Necochea and Cline (1996), is a critical step toward equity. While guides for motivated individuals, such as the one from Rishab Academy (Nagarajan, 2024), offer practical steps for finding a mentor within a flawed system, a truly equitable approach requires systemic solutions that institutionalize mentorship. The seven steps for students include:

1. Identifying project interests to target the right experts.
2. Reaching out to teachers and professors.

3. Utilizing online platforms dedicated to mentorship.
4. Joining science clubs and community organizations.
5. Attending science fairs and workshops to network.
6. Using social media like LinkedIn to connect with professionals.
7. Leveraging formal mentorship programs.

The university partnership model proposed by Necochea and Cline (1996), provides the necessary systemic solution. By establishing formal mentorship networks between the universities and local K-12 Title I schools, one can directly address the mentorship gap in underserved communities. Such partnerships remove the burden from individual students and teachers to build their own networks and instead provide institutional access to culturally responsive mentors, expert knowledge, and university resources, thereby leveling the playing field.

Innovative and Alternative Fair Formats

Rethinking the very structure of the science fair can make it more accessible and impactful. The “Flipped Science Fair” model, detailed by Lewis et al. (2023), offers a compelling case study. In this format, the roles are reversed: children act as judges, and graduate student researchers are the presenters. This model directly dismantles barriers identified in Section 3. By shifting the locus of activity to a community space and positioning children as authorities, it mitigates the “double-edged sword of parental involvement” (Fields et al., 2022) and helps overcome the “cultural disconnects” (Necochea & Cline, 1996) of traditional science fairs. Its dual benefits are empowering children as valued contributors and providing graduate students with crucial science communication training, particularly when the audience members are much younger than them which calls for an increased command over exposition and grasp over the material. Another thought that was highlighted was to develop partnership with local city public libraries. This was shown to be a key strategic element, lowering barriers to entry by hosting the event in a familiar, accessible community space rather than on a university campus.

Other alternative formats also broaden the appeal of science fairs:

- Kids Inquiry Conference: Replaces the competitive model with a collaborative one similar to professional science conferences, where students share discoveries with peers.
- Invention Convention: An engineering-focused event where students identify a need and follow the research and development process to create an invention.
- School Maker Faire: An interdisciplinary showcase where students display projects or lead hands-on activities in any area where they have developed expertise, from science and engineering to art and craft.

Building a Systemic Ecosystem of Support

Equity requires a multi-faceted support system that addresses financial, logistical, and resource-based needs.

Financial Resources

The Clear Creek Education Foundation’s (CCEF) “Science Fair Innovative Grant (SFIG)” program is a prime example of a targeted intervention. This program offers microgrants of up to \$500 directly to secondary students to purchase materials and enhance their projects,

removing the financial burden that exacerbates inequity (Clear Creek Education Foundation, 2025).

In-School Project Work

To counter inequities stemming from varied home environments, and parental social capital, Fields et al. (2022) strongly recommend making project work an in-school activity. This ensures all students have access to teacher guidance, materials, and time, regardless of parents' availability or resources.

Free Digital and Organizational Resources

A robust ecosystem of free resources is available to support students and teachers. We list a few for reference in this section: Organizations such as the Society for Science (<https://www.societyforscience.org/>), Science Buddies (<https://www.sciencebuddies.org/>), and the Synopsys Outreach Foundation (<https://outreach-foundation.org/>) provide extensive online libraries of project ideas, lesson plans, and guidance (Santa Clara Valley Science and Engineering Fair Association, Jan 2026.). Science Buddies offers a “Topic Selection Wizard” to help students find projects, while the Society for Science provides free access to science news and associated curricula to thousands of public schools.

Integrating Formal and Informal STEM Learning

Effective science fairs should not exist in a vacuum. K-12 students spend only 18.5% of their waking hours in formal learning environments, highlighting the importance of “lifelong and lifewide learning” across settings like libraries, museums, and home (STEM Teaching Tools, 2026). The most impactful science education connects these different spheres into a cohesive “STEM Learning Ecosystem”. The Flipped Science Fair’s partnership with the public library is a prime example of this integration, intentionally connecting a university’s academic resources with a community-based informal learning institution. By building these bridges, educators can create more sustained, relevant, and equitable learning pathways for all students. These innovative models and systemic supports demonstrate that a more equitable and engaging science fair is not just a theoretical ideal but an achievable reality.

Discussion and Implications

The evidence presented in this paper points toward a clear and urgent need to evolve the science fair from an isolated, often inequitable competition into an integrated, collaborative, and essential component of a community’s STEM learning ecosystem. The traditional model, with its heavy reliance on out-of-school work and parental resources, is no longer sufficient to meet the needs of a diverse student population. The implications of this conclusion are significant for all stakeholders involved in STEM education.

For K-12 Educators and Administrators

The findings challenge schools to rethink the fundamental structure of their science fairs. As recommended by Fields et al. (2022), administrators should consider making fairs mandatory, in-school events to ensure universal participation and level the playing field. This requires allocating sufficient curricular time, providing materials, and actively building partnerships

with outside organizations to supply the mentorship and resources that may be lacking internally.

For University and STEM Professionals

Higher education institutions and STEM professionals have both an opportunity and a responsibility to contribute to a more equitable K-12 pipeline. The models from Virginia Tech (the “Flipped Science Fair”) demonstrate the powerful impact of such an engagement. Such partnerships not only benefit K-12 students but also provide valuable communication and leadership training for graduate students and faculty.

For Community Organizations and Foundations

Community partners are critical agents in bridging equity gaps. The roles played by public libraries in providing a neutral and accessible venue and the Clear Creek Education Foundation in offering direct financial microgrants are indispensable. These organizations can provide flexible resources, funding, and community trust needed to support initiatives that schools alone cannot sustain.

Revisiting the NASEM equity frames, the innovative models discussed actively address multiple dimensions of equity. University mentorships, library partnerships, and microgrants directly contribute to “Expanding Opportunity and Access” by bringing high-quality STEM resources and experiences to students in underserved communities. Furthermore, by empowering children as judges in the Flipped Science Fair and valuing their diverse perspectives, these models help in “Embracing Heterogeneity”, showing students that their voices and experiences are valued within the scientific community. By moving away from a single, rigid format, these approaches create a more just and inclusive vision for STEM engagement.

Conclusion

The traditional science fair, while rooted in the noble goal of fostering scientific inquiry, is insufficient for today’s diverse and complex educational landscape. Its structure often amplifies existing societal inequities, creating barriers that prevent countless students from fully participating and benefiting. The central argument of this paper is that fundamental redesign is necessary, one that shifts the focus from individual competition to collaborative, community-supported learning.

The widespread adoption of the equitable and innovative practices discussed throughout this analysis offers a clear path forward. By establishing formal mentorship programs, embracing alternative fair formats, providing direct financial support, and integrating in-school and out-of-school learning, the educational community can dismantle long-standing barriers. The evidence is unequivocal: incremental adjustments are insufficient. The path forward requires systemic restructuring guided by the principles of equity, collaboration, and inclusion. By reimagining science fairs as tools for equity rather than exclusivity, we can finally unlock the scientific potential and brilliance of every single learner.

Author's Note

Our objective in this article is to reimagine the science fair through an examination of the pedagogical value it provides and to explore the inherent equity barriers in the secondary school education system. We then outline potential innovative models for a more inclusive approach to STEM engagement among Title I middle and high school students.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The authors declare that Grammarly, an AI-assisted writing software, was used in proofreading and refining the language used in the manuscript. The usage was limited to correcting grammatical and spelling errors and rephrasing statements for accuracy and clarity. The authors further declare that, apart from Grammarly, no other AI or AI-assisted technologies have been used to generate content in writing the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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Contact emails: nks001@shsu.edu
cxv007@shsu.edu
axr249@shsu.edu

ICT-Based Instructional Materials and Butterfly Stroke Skill Acquisition in Junior High School Students: A Pre–Post Evaluation

Kazumasa Ozeki, Osaka University of Health and Sport Sciences, Japan
Shunsuke Ogura, Wakamizu Junior High School, Japan
Yasuhiro Kawashima, Osaka University of Health and Sport Sciences, Japan

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Abstract

Butterfly is considered particularly challenging to learn in Japanese junior high school physical education, and reduced swimming opportunities during the COVID-19 pandemic may have further intensified this difficulty. This study examined whether butterfly swimming skills improved over a nine-lesson unit supported by ICT-based instructional materials. Participants were 75 Grade 9 students from a junior high school in Nagoya, Japan. Students who were absent for three or more lessons were excluded, resulting in 66 participants. In Lessons 1 and 9, students performed a maximal-effort 25 m butterfly swim (water start; permitted to stop if breathless). Swimming movements were recorded from an above-water lateral view using a tablet device (approximately 3 m; 60 fps). Two trained raters evaluated the videos using a 12-point scale comprising four components (posture, kick, pull, and breathing; 1–3 points each). Inter-rater reliability was high ($ICC(2,1) = 0.881$; $ICC(2,2) = 0.937$). Total skill scores increased from 6.33 ± 2.76 at pre-test to 8.05 ± 2.59 at post-test (Wilcoxon signed-rank test, $p < .001$, $r = .78$; $N = 66$). All component scores also increased ($p < .001$; $r = .62-.73$). After the unit, 58 of 66 students (87.9%) managed to complete a 25 m butterfly swim. Although the lack of a control group limits causal inference, the findings suggest that ICT-based materials may support butterfly skill acquisition in school-based swimming instruction, even under restrictions on device use at the poolside.

Keywords: ICT-based learning materials, butterfly stroke, physical education, skill acquisition

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Introduction

In Japanese junior high school physical education, students are expected to acquire proficiency in the four competitive strokes—front crawl, breaststroke, backstroke, and butterfly (Ministry of Education, Culture, Sports, Science and Technology [MEXT], 2017). The curriculum also requires students to understand key technical elements of each stroke and fitness components that can be developed through swimming. Although swimming is a whole-body activity that may contribute to improvements in cardiorespiratory fitness and endurance, it is also a unit in which large inter-individual differences in swimming ability can make lesson design and instruction challenging. Butterfly is considered difficult for many learners because it requires simultaneous coordination of undulatory body motion, upper- and lower-limb actions, and breathing timing. In addition, in a class setting, it may be difficult for teachers to demonstrate movements in detail underwater or provide immediate feedback, which can further constrain instruction.

In recent years, the COVID-19 pandemic led many schools to restrict or suspend swimming lessons. Consequently, opportunities for students to practice aquatic skills decreased, and practitioners reported that, even after lessons resumed, some students continued to show reduced swimming ability and increased reluctance or anxiety toward swimming. In addition, many teachers have expressed concerns about how to structure stepwise learning while ensuring safety and fostering skill development in classes that include such learners. Under these circumstances, in addition to securing sufficient practice time during lessons, support may be needed to help learners form clear movement images and select appropriate practice methods.

The use of ICT-based learning materials and video-based instruction may help address these issues. Because movement images can be difficult to develop through verbal explanation alone, visual support using above- and underwater videos may facilitate students' understanding of swimming techniques. However, the pool environment poses substantial constraints on device use and safety management, and research on ICT implementation in school-based physical education remains limited. Kretschmann (2017) examined the use of tablet-based video feedback in elementary school swimming lessons and highlighted the feasibility of ICT-supported learning in pool settings. However, the targeted skills were mainly front crawl. Empirical evidence focusing on butterfly—an especially challenging stroke that may also be difficult for teachers to demonstrate—remains scarce. Scurati et al. (2019) reported that supplementary feedback delivered via mobile devices significantly improved stroke evaluation in breaststroke among university students specializing in sport science. However, further evidence is required across strokes and age groups. Taken together, the extent to which stepwise learning support using ICT-based materials is associated with learning outcomes in butterfly in school-based swimming instruction remains unclear. Moreover, there is a need for implementation studies that examine not only one-off video presentations or feedback but also the instructional design of ICT materials tailored to learners' skill stages (i.e., what to present, in what sequence, and from which viewpoints).

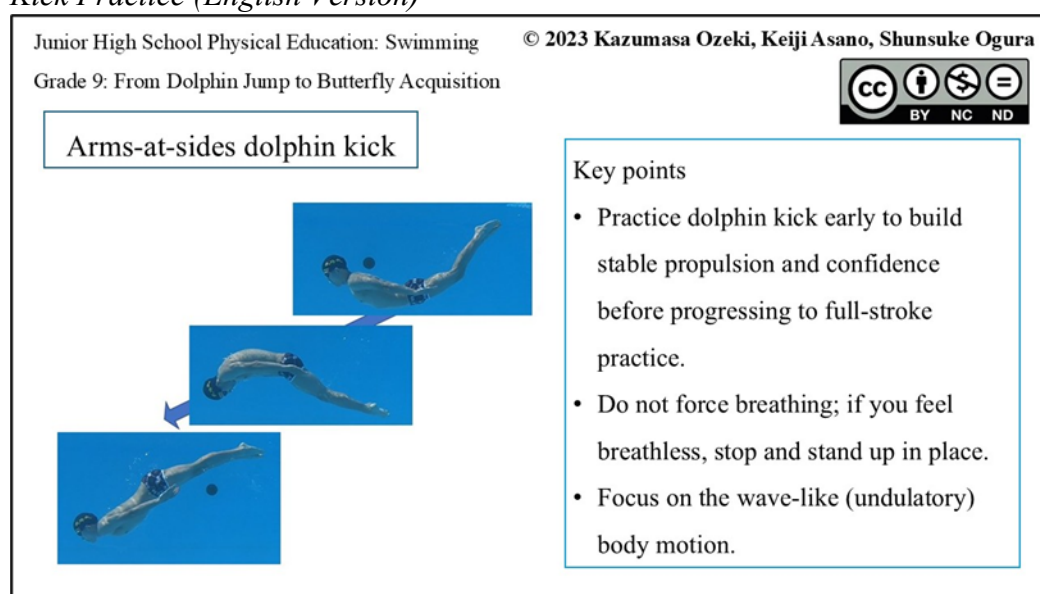
In this study, we developed ICT-based learning materials using LoiLoNote (LoiLo Inc.), a platform currently used in educational settings in Nagoya, Aichi Prefecture, Japan. The materials were designed to facilitate visual understanding of fundamental swimming movements and to support systematic, practical learning by presenting videos and photographs in a stepwise manner according to skill level (Figure 1). In addition, considering that some students may have had limited learning experience in upper elementary school with front crawl,

breaststroke, and safety-related aquatic skills, the program was structured to connect safety-oriented learning with subsequent stroke acquisition. The materials were intended to support teachers in delivering stepwise instruction in classes that include students with reduced swimming ability and/or negative attitudes toward swimming.

This study aimed to examine changes in butterfly swimming skill (total score and component scores) over a nine-lesson unit among Grade 9 students at a junior high school that implemented these ICT-based materials, using a pre–post design. The findings are intended to provide foundational evidence on the implementation of ICT-based learning materials in school-based swimming instruction, with a particular focus on butterfly skill acquisition.

Figure 1

Example Screen From the ICT-Based Learning Material Illustrating Key Points for Dolphin Kick Practice (English Version)



Source: Ozeki et al., 2023. (CC BY-NC-ND).

Methods

ICT-Based Learning Materials

In many Japanese junior high schools, swimming instruction typically covers front crawl in Grade 7, breaststroke in Grade 8, and backstroke in Grade 9. Butterfly is often not taught in class. Therefore, the current ICT-based learning materials were structured to enable stepwise learning toward butterfly acquisition.

In Grade 7, the materials prioritized the development of aquatic self-preservation skills, with an emphasis on safety-related skills such as floating and breathing. Specifically, the materials included elementary backstroke—selected because it facilitates a transition from supine floating and allows breathing in a stable, face-up posture—and “butterfly-style swimming” and “Clione backstroke” as learning tasks. Hamagami et al. (2015) reported that acquiring backstroke before front crawl may lead to greater improvements in swimming skills, partly because the breathing demand is relatively lower in backstroke. Consistent with this rationale, the materials were intended to reduce the fear of water through backstroke (or backstroke-like

activities) and to create a learning environment in which students can engage more proactively in swimming instruction.

In Grades 8 and 9, the materials included instructional videos required for acquiring breaststroke and butterfly, building on the safety-related skills developed in Grade 7. For breaststroke, to address “whip kick with excessive abduction” (a common stumbling point in skill acquisition), the materials also presented a land-based drill (Hira-kick exercises; Ikuta et al., 2021) to encourage self-directed practice outside class. Because butterfly is difficult to acquire and for teachers to demonstrate sufficiently, the materials included extensive above- and underwater model videos. In addition, multiple-practice-method videos were provided so that students could identify their own challenges and obtain cues for improvement through trial and error.

Use of the ICT-Based Material

At the target school, students were not allowed to view or record videos using learning tablets at the poolside. Accordingly, the materials were used before and after pool practice.

During the first half of the unit, the materials were used to help students form a target movement image and understand key technical points. After viewing the videos and sharing key points in the classroom, students moved to the pool and practiced while confirming the technical points and practice methods introduced in the videos.

During the second half of the unit (problem-solving learning), the materials were used as a resource to help students select practice methods based on their individual goals for the lesson. Students were supported in selecting and modifying practice methods for their own challenges while referring to the videos.

Participants and Study Design

Participants were 75 Grade 9 students (38 boys and 37 girls) from a junior high school in Nagoya, Aichi Prefecture, Japan. Changes in the butterfly swimming skill over a nine-lesson unit were examined using a pre–post design. Students who were absent for three or more lessons ($n = 9$) were excluded, resulting in 66 participants.

Swimming Task and Video Recording

In Lessons 1 and 9, students were instructed to perform a maximal-effort 25 m butterfly swim. A water start was used, and students were permitted to stop mid-trial if they experienced difficulty breathing. Swimming movements were recorded from above water using a tablet device positioned laterally to the swimmer at an approximate distance of 3 m, with a recording rate of 60 fps.

Skill Assessment and Reliability

Butterfly skill was evaluated by two trained raters after sharing scoring criteria and conducting pilot scoring (one university faculty member specializing in swimming and one junior high school physical education teacher with experience in swimming instruction and lesson study). A 12-point scale was developed based on previous studies (Yasuda et al., 2023). The scale

comprised four domains—posture, kick, pull, and breathing—each scored on a 3-point scale (total score range: 0–12).

Inter-rater reliability was assessed using the intraclass correlation coefficient (ICC) based on a two-way random-effects model with absolute agreement. The ICC for single measures (ICC(2,1)) was 0.881 (95% CI [0.828, 0.921]), whereas that for average measures (ICC(2,2)) was 0.937 (95% CI [0.906, 0.959]).

Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics version 27.0 (IBM, Armonk, NY, USA). Pre–post differences were tested using the Wilcoxon signed-rank test. Effect size was calculated as $r = |Z|/\sqrt{N}$, where N denotes the number of participants. Statistical significance was set at $p < .05$.

Results

The total butterfly swimming scores increased from $M = 6.33$ ($SD = 2.76$) at pre-test to $M = 8.05$ ($SD = 2.59$) at post-test (Wilcoxon signed-rank test, $p < .001$, $r = .78$; $N = 66$) (Figure 2). Component scores for posture, kick, pull, and breathing also increased from pre-test to post-test ($p < .001$), with effect sizes ranging from $r = .62$ to $.73$ (Table 1). After the unit, 58 of the 66 students (87.9%) managed to complete a 25 m butterfly swim.

Figure 2

Total Butterfly Swimming Skill Scores at Pre-test and Post-test ($N = 66$)

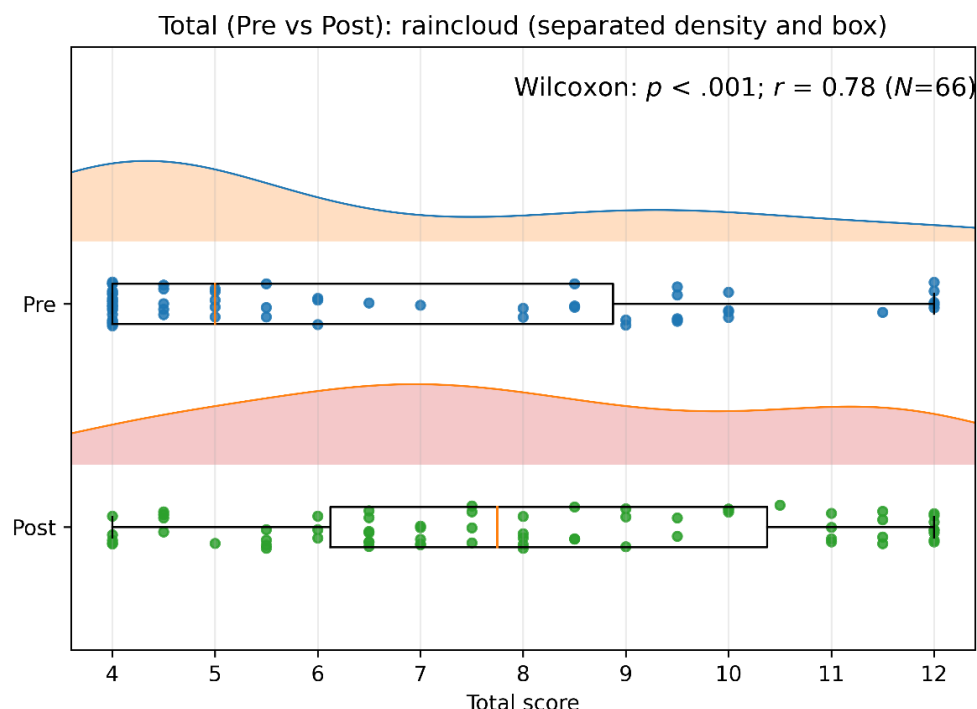


Table 1*Component Scores (0–3 Points) at Pre-test and Post-test (N = 66)*

Component	Pre (mean ± SD)	Post (mean ± SD)	Pre median [IQR]	Post median [IQR]	<i>p</i>	<i>r</i>	Ties ($\Delta=0$)
Posture	1.48 ± 0.71	1.98 ± 0.71	1.0 [1.0–2.0]	2.0 [1.5–2.5]	< .001	0.71	24
Kick	1.67 ± 0.75	2.02 ± 0.76	1.5 [1.0–2.0]	2.0 [1.5–2.75]	< .001	0.68	32
Pull	1.54 ± 0.69	2.01 ± 0.67	1.0 [1.0–2.0]	2.0 [1.5–2.5]	< .001	0.73	21
Breathing	1.64 ± 0.73	2.04 ± 0.70	1.5 [1.0–2.5]	2.0 [1.5–2.5]	< .001	0.62	24

Discussion

This study examined whether the butterfly swimming skills of Grade 9 students improved over a nine-lesson unit supported by ICT-based learning materials. The total skill scores increased significantly from pre-test to post-test, and all component scores (posture, kick, pull, and breathing) also improved. These findings suggest that visually supported instruction using ICT materials may be associated with skill learning in junior high school swimming lessons.

Swimming skills can be difficult to represent mentally through verbal instruction alone. Butterfly imposes a high cognitive and motor demand because it requires coordinated movements and precise breathing timing. The ICT materials used in this study included above- and underwater model videos with key technical points, which may have facilitated observational learning and clarified the instructional focus. Kretschmann (2017) reported the use of tablet-based video feedback in elementary school swimming classes, suggesting that video-supported learning can be feasible in pool settings. The present findings extend this perspective by indicating that learning support may still function under constraints that prevent device use at the poolside, through short viewing sessions before and after pool practice.

In the latter half of the unit, students selected practice methods while referring to the videos, which may have supported self-regulated learning through identifying individual issues and choosing appropriate drills. Scurati et al. (2019) reported that supplementary feedback delivered via mobile devices improved stroke evaluation in breaststroke among university students. Although the participants and stroke differed, the present results are consistent with the notion that video- and device-mediated information can contribute to skill improvement.

Effect sizes for the components ranged from $r = .62$ to $.73$, indicating that the magnitude of improvement differed across elements. Posture and pull may be more readily recognized and imitated from video due to their visible movement characteristics, whereas breathing involves timing control and may also be influenced by discomfort or resistance to water, potentially resulting in smaller short-term gains. In addition, the 3-point component scale likely produced tied scores and may have reduced sensitivity to small changes.

Conclusion

A nine-lesson unit using ICT-based learning materials built on LoiLoNote was associated with improvements in butterfly swimming skills (both total and component scores) among Grade 9

students. Even in school settings where device use is restricted at the poolside, brief viewing sessions before and after pool practice may allow practical implementation. Stepwise presentation of above- and underwater videos may help standardize instruction and support learners' understanding, particularly for butterfly, which can be difficult for teachers to demonstrate.

This study had two key limitations. First, because a pre-post design without a control/comparison group was used, the observed improvements cannot be attributed uniquely to the ICT-based materials; practice volume, instructional strategies, maturation, and familiarity with the lessons may also have influenced the outcomes. Second, participants were drawn from a single junior high school (Grade 9); therefore, generalizability to other grades and school contexts should be interpreted cautiously.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that ChatGPT 5.2 (OpenAI) was used as an AI-assisted tool for proofreading and language refinement, including translation support. The use was limited to improving clarity and academic writing style. The research ideas, design, procedures, findings, analyses, and discussion are the author's original work.

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Contact email: ozeki@ouhs.ac.jp

Teacher Self-Use Predicts Classroom Adoption of Generative AI Among Japanese High School Informatics Teachers

Shunsuke Inagaki, University of Yamanashi, Japan

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Abstract

Generative AI (GenAI) is rapidly entering schools, but teacher adoption is shaped not only by positive expectations (e.g., perceived usefulness) and concerns (e.g., accuracy, copyright, and governance) but also by teachers' everyday experience using these tools in their own work. This study examines a two-stage model of GenAI adoption among Japanese high school Informatics teachers: (1) intention to use GenAI in class and (2) classroom adoption (whether GenAI has already been used in class). A nationwide online survey was administered in May 2025 to Informatics teachers across Japan ($n = 104$). Expectations, concerns, and intention were measured with multi-item scales; self-use frequency was measured on a four-level ordinal scale; and classroom adoption was measured as a binary outcome. Analytic sample sizes varied slightly by model due to item nonresponse. In Stage 1, ordinary least squares regression showed that expectations ($B = 0.67$, $p < .001$) and self-use frequency ($B = 0.25$, $p = .003$) predicted stronger intention, whereas concerns were not a significant predictor. In Stage 2, logistic regression showed that self-use frequency predicted classroom adoption ($OR = 2.33$, $p = .010$), while expectations and concerns were not significant when self-use was included. Predicted adoption probabilities rose from 0.33 (trial only) to 0.86 (almost daily self-use) at median expectations and concerns ($AUC = 0.679$). These findings suggest that expectations are sufficient to generate intention, but sustained self-use may be a practical bridge to classroom adoption. Implications are discussed for professional development that builds short, authentic self-use routines and for school-level guidelines that operationalise key concerns as simple, checkable classroom rules.

Keywords: generative AI, teacher adoption, informatics education, technology acceptance, professional development

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Introduction

Generative AI (GenAI), including large language model (LLM)–based tools such as ChatGPT and Copilot, is increasingly available to teachers and students. Because these tools can generate natural language text, code, and other artefacts on demand, they can potentially support teaching and learning in ways that differ from earlier educational technologies: teachers can request examples, explanations, alternative representations, and formative feedback at the point of need. At the same time, GenAI introduces distinctive risks for schooling. Outputs can be plausible but incorrect; the provenance of information can be opaque; and classroom use intersects with copyright, privacy, and academic integrity. As a result, policy and governance discussions increasingly emphasise not only access, but also transparency, verification, and the continued role of human responsibility (Miao & Holmes, 2023; Organisation for Economic Co-operation and Development [OECD], 2023).

Japan has responded to these challenges through national guidance. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) released guidance for primary and secondary education that frames GenAI as a tool to be used under human oversight, with explicit attention to information accuracy, ethical considerations, and school-level governance (MEXT, 2024). In practice, however, schools and local boards of education vary in how quickly they develop policies and how strongly they restrict access (e.g., network blocks). Such heterogeneity creates uncertainty for teachers, who must decide whether and how to integrate GenAI while being accountable to students, parents, and institutional rules.

High school Informatics in Japan is a particularly consequential context for GenAI adoption. Informatics is a compulsory subject for almost all students, and its learning goals include problem solving with digital tools, programming and networks, and data utilisation. These goals naturally connect to GenAI literacy: students need to understand what GenAI can and cannot do, how to prompt and evaluate outputs, and how to use tools responsibly in real tasks. Informatics teachers therefore occupy a dual role. They are both potential users of GenAI for lesson preparation and assessment, and also responsible for guiding students' safe and critical use. Because the subject is compulsory, teacher decisions in Informatics can influence a large proportion of students' opportunities to develop AI-relevant information-utilisation competencies.

Despite strong public attention to GenAI, teacher adoption is rarely a single, static decision. Teachers may endorse GenAI in principle—believing it could improve efficiency or enrich learning—while still delaying classroom use due to concerns, institutional constraints, or limited personal familiarity. Importantly, intention and behaviour can diverge (Ajzen, 1991). Intention reflects willingness, whereas classroom adoption requires concrete enactment: preparing activities, managing student use, handling accountability for mistakes, and aligning with school rules. Consequently, understanding adoption requires attention to both motivational determinants (e.g., expectations of benefit) and practical determinants that enable enactment (e.g., hands-on experience and routines).

This study therefore proposes and tests a two-stage model of GenAI adoption among Japanese high school Informatics teachers. Stage 1 models teachers' intention to use GenAI in Informatics lessons as a function of expectations, concerns, and self-use frequency. Stage 2 models whether teachers have already adopted GenAI in class (yes/no), using the same predictors. By separating intention from adoption, the analysis clarifies which factors primarily shape “wanting to use” versus “already using,” and it informs professional development (PD)

and governance strategies that can better bridge policy guidance and classroom practice. The study also contributes empirical evidence from a subject area—Informatics—where GenAI literacy and information ethics are not peripheral but central to the curriculum.

Another reason the Informatics context is important is that the subject area is undergoing rapid expansion. Teachers are expected to address not only conventional computing topics but also data science—adjacent practices, AI literacy, and ethical issues in digital society. In many schools, Informatics teachers teach across multiple grades and must align instruction with high-stakes assessment expectations and school-wide digital policies. Professional development opportunities on GenAI are still uneven, so many teachers rely on self-directed exploration and peer communities. In this environment, teachers' personal self-use of GenAI becomes a plausible entry point to later classroom adoption: it is often the most immediately accessible way to learn what the tools can do, what can go wrong, and how to build checking routines before exposing students to risks.

Literature Review and Conceptual Framework

Technology Acceptance and Teacher Adoption

Research on educational technology adoption commonly models teachers' behavioural intention as a proximal predictor of later use. This focus aligns with the technology acceptance model (TAM) (Davis, 1989). Prominent frameworks such as the Unified Theory of Acceptance and Use of Technology (UTAUT) highlight perceived performance benefits, effort expectancy, social influence, and facilitating conditions as key determinants of intention and use (Venkatesh et al., 2003). Across many technologies, perceived usefulness or value tends to be a strong predictor of intention, particularly when teachers see clear benefits for instructional effectiveness or workload. However, actual use is also shaped by practical constraints (e.g., access and policy) and by teachers' confidence and routines in integrating tools into authentic classroom practice. In GenAI contexts, emerging research echoes these patterns while emphasising new dimensions. Studies have reported that teachers' perceived value of GenAI and their confidence in using it are associated with stronger intention to integrate GenAI tools at work, including in planning and instructional tasks (Collie et al., 2024; Kong et al., 2024). These findings suggest that standard acceptance constructs remain relevant, but they also highlight the need to account for how teachers learn to use GenAI responsibly, including how they verify outputs and manage risks.

Expectations, Concerns, and Governance

GenAI has features that intensify the coexistence of hope and worry. On the one hand, teachers may expect GenAI to save time, provide alternative explanations, and generate creative ideas. On the other hand, they may worry about inaccurate or biased outputs, unclear authorship, copyright infringement, and privacy problems. Policy reports emphasise that responsible educational use depends on explicit norms and governance structures, including disclosure of use, verification of key claims, and data protection (MEXT, 2024; OECD, 2023). From the perspective of individual teachers, such governance can appear as both enabling and constraining: clear rules may reduce uncertainty and support safe experimentation, whereas unclear or restrictive rules may suppress classroom trials regardless of a teacher's interest. Reports and surveys in Japan indicate that expectations and concerns are simultaneously present among educators and students, reflecting simultaneous interest in potential benefits (e.g., efficiency and idea generation) and awareness of risks (e.g., accuracy and ethics).

Moreover, teacher experience with GenAI may shape how these expectations and concerns are evaluated. Noborimoto et al. (2023) reported differences in perceptions and attitudes between primary and secondary teachers who had used GenAI and those who had not. Such findings suggest that personal experience may not simply reduce concerns; rather, experience may help teachers differentiate manageable concerns (addressed through checking routines) from non-negotiable constraints (e.g., prohibited access).

Self-Use as Experience and Routine

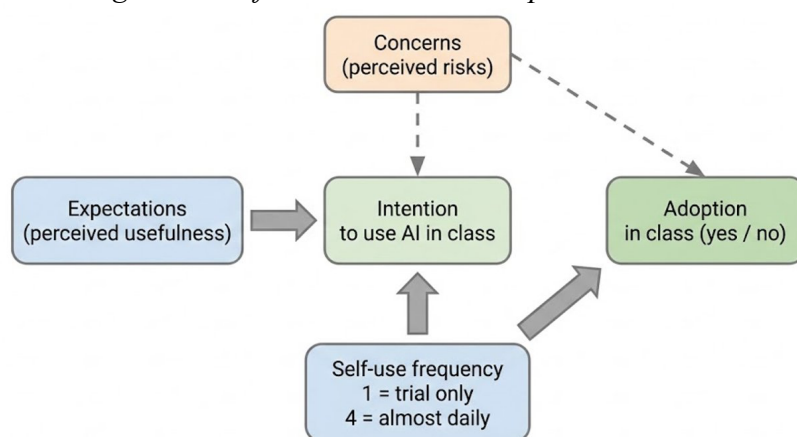
A distinctive feature of GenAI adoption is that many teachers can use these tools privately before introducing them to students. This creates a potential developmental pathway: teachers first use GenAI for their own work (self-use), then consider whether and how to involve students. Self-use frequency is therefore more than a background variable; it is a proxy for experience and emerging routines. Frequent self-use may help teachers learn prompting strategies that produce useful outputs, recognise common failure modes, and develop habits of checking and revising. Such procedural knowledge can reduce the subjective cost of classroom implementation and can increase confidence that risks can be managed in front of students.

Two-Stage Model of Adoption

Based on these considerations, this study adopts a two-stage model (Figure 1) that distinguishes between intention and adoption. In Stage 1 (intention), expectations are expected to play a major role because teachers are likely to form willingness to try GenAI when they anticipate clear benefits. Concerns may reduce intention to the extent that they are perceived as severe or uncontrollable. Self-use may also strengthen intention because it increases familiarity and perceived feasibility. In Stage 2 (adoption), self-use is expected to be particularly important because classroom adoption requires enactment—designing activities, managing students, and responding to errors—which depends heavily on practical fluency and routines. Expectations may be sufficient to generate intention but may not be sufficient for adoption once self-use is considered. Concerns may remain important for the quality and governance of implementation even if they do not statistically distinguish adopters from non-adopters. Accordingly, the study addresses two research questions. RQ1: How do expectations, concerns, and self-use frequency relate to teachers' intention to use GenAI in Informatics lessons? RQ2: How do the same factors relate to classroom adoption (whether GenAI has already been used in class)?

Figure 1

Two-Stage Model of Teacher GenAI Adoption



Note. Solid lines indicate hypothesised positive paths; dashed lines indicate hypothesised negative paths.

Methodology

Participants and Procedure

A nationwide online survey was administered from May 9 to May 17, 2025. Participants were high school teachers responsible for Informatics courses (including Informatics I and related subjects). Recruitment used professional networks and online channels commonly used by Informatics teachers (e.g., teacher communities and social media). A total of 104 valid responses were collected. Respondents included 85 men and 15 women; 2 respondents did not answer the gender item and 2 selected “prefer not to say.” Most respondents reported teaching Informatics I ($n = 91$), and many also taught school-specific Informatics-related subjects ($n = 40$), general “inquiry-based learning” periods ($n = 37$), or Informatics II ($n = 18$). Regarding grade level, 73 respondents reported teaching Grade 10, 50 taught Grade 11, and 55 taught Grade 12 (multiple selections were allowed). School type was reported as public ($n = 34$), private ($n = 28$), or national ($n = 2$), but this item had substantial nonresponse ($n = 39$). Because the survey was voluntary and online, the sample should be interpreted as a national convenience sample rather than a probability sample. Nevertheless, respondents came from a range of school contexts and grade levels, providing a useful snapshot of Informatics teachers’ perceptions and practices during a period of rapid policy and technological change. All responses were anonymised, and participation was optional. Analytic sample sizes varied slightly across models due to item nonresponse. Figure 2 provides a visual overview of the nationwide sample ($n = 104$).

Figure 2

Nationwide Online Survey Sample



Note. High school informatics teachers in Japan; $n = 104$.

Measures

Expectations. Expectations of GenAI use were measured with four items addressing perceived reduction of work time, improved understanding through clearer explanations, support for creative ideas, and reduced fatigue or stress. Responses used a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). A composite expectations score was computed as the mean of the four items ($\alpha = .71$). **Concerns.** Concerns about GenAI use were measured with four items

addressing accuracy anxiety, ethics and copyright, lack of school/government guidelines or restrictions, and blocked access in school networks. Responses used the same 5-point Likert scale. A composite concerns score was computed as the mean of the four items ($\alpha = .43$). Given the heterogeneity of concern content, this composite should be interpreted as a broad index of perceived risk and constraint rather than a unidimensional scale. Intention to use in class. Intention was measured with five items addressing willingness to use GenAI actively in future lessons, to recommend use to colleagues, and to increase opportunities for students to use GenAI appropriately in class and at home. Responses used the same 5-point Likert scale, and the composite intention score was the mean of the five items ($\alpha = .90$). Self-use frequency. Teachers' self-use frequency during the previous month was measured on a four-level ordinal scale: trial use only, monthly use, weekly use, and almost daily use. This variable operationalises the extent to which GenAI is already incorporated into teachers' everyday work routines. Higher values indicate more frequent self-use. Classroom adoption. Classroom adoption was measured as a binary variable indicating whether the teacher had already addressed or used GenAI in class (0 = no, 1 = yes). The survey also asked teachers who had adopted GenAI to indicate the types of classroom activities used (e.g., conceptual introductions, demonstrations, student prompting activities, and ethics/copyright instruction), which are reported descriptively.

Data Processing and Analytic Strategy

Scale scores were computed as mean scores to preserve the original response metric (1–5). Descriptive statistics were computed for all variables. Because the self-use measure is ordinal and adoption is binary, bivariate associations were summarised using Spearman correlations. To test the two-stage model, Stage 1 used ordinary least squares regression predicting intention from expectations, concerns, and self-use frequency. Stage 2 used logistic regression predicting classroom adoption from the same predictors. Missing data were limited for the main predictors, with two missing values for self-use frequency and two missing values for adoption; the multi-item scales had complete responses. Regression models therefore used listwise deletion, resulting in slightly smaller analytic samples. For Stage 2, odds ratios (OR) are reported for interpretability, and model performance is summarised with the area under the ROC curve (AUC) and the Brier score.

Results

Descriptive Patterns of Use

Almost all respondents reported having personally used GenAI at least once (102 of 104). Self-use frequency during the previous month was reported as trial use only ($n = 5$), monthly use ($n = 20$), weekly use ($n = 39$), or almost daily use ($n = 38$); two responses were missing. When asked about contexts of GenAI use (multiple selections), teachers most commonly reported using GenAI for lesson preparation ($n = 80$), information search ($n = 70$), self-learning or skill development ($n = 57$), and administrative document writing ($n = 54$). Many also reported using GenAI for creative production such as images, music, or video ($n = 48$). These patterns suggest that, for many Informatics teachers, GenAI is already embedded in professional tasks beyond classroom instruction. Classroom adoption was reported by 74 teachers, while 28 reported they had not yet used GenAI in class (two missing responses). Among adopters, the most common classroom activities (multiple selections) were introducing basic concepts of GenAI ($n = 58$), demonstrating GenAI tools in class ($n = 52$), providing students with hands-on prompting experiences ($n = 42$), and addressing ethics and copyright issues ($n = 40$). Some teachers also

reported incorporating GenAI into report-writing tasks ($n = 28$). Taken together, these responses indicate that early classroom adoption in Informatics often focuses on foundational understanding, demonstration, and controlled student experimentation rather than unrestricted or high-stakes use.

Descriptive Statistics and Correlations

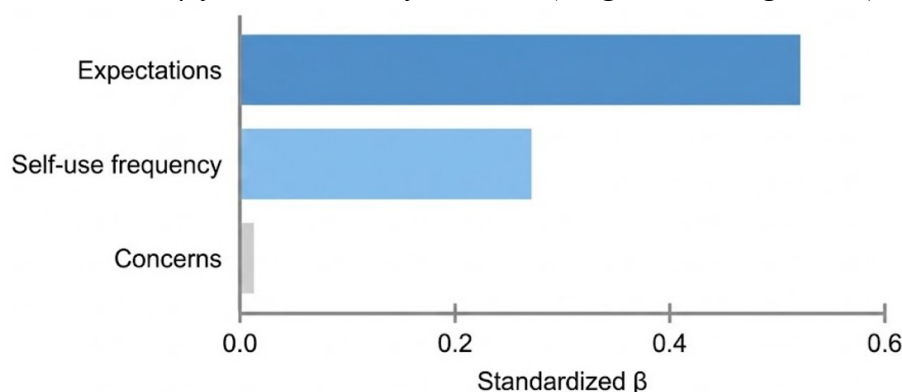
Respondents reported moderately high expectations for GenAI ($M = 3.99$, $SD = 0.64$) and moderately high intention to use GenAI in class ($M = 4.09$, $SD = 0.81$). Concerns were moderately high ($M = 3.39$, $SD = 0.73$), indicating that positive expectations and perceived risks coexisted. Spearman correlations (Table 1) indicated a strong positive association between expectations and intention ($\rho = .70$), consistent with acceptance models emphasising perceived usefulness. Self-use frequency was also strongly associated with intention ($\rho = .59$). By contrast, intention showed only a weak association with classroom adoption ($\rho = .01$), whereas self-use frequency showed a positive association with adoption ($\rho = .26$). Concerns showed small negative associations with expectations and self-use frequency.

Stage 1: Predicting Intention

Stage 1 regression results are shown in Table 2. The model explained 58.2% of variance in intention ($R^2 = .500$). Expectations were a strong positive predictor of intention ($B = 0.67$, $SE = 0.07$, $\beta = .52$, $p < .001$). Self-use frequency was also a positive predictor ($B = 0.25$, $SE = 0.05$, $\beta = .27$, $p = .003$). Concerns were not a statistically significant predictor of intention when expectations and self-use were included ($B = 0.03$, $SE = 0.08$, $\beta = .03$, $p = .674$). Figure 3 visualises the standardized β coefficients.

Figure 3

Standardized β for Predictors of Intention (Stage 1 OLS Regression)



Stage 2: Predicting Classroom Adoption

Stage 2 logistic regression results are shown in Table 3. Self-use frequency predicted classroom adoption ($B = 0.85$, $SE = 0.33$, $OR = 2.33$, $p = .010$), indicating that each one-level increase in self-use frequency approximately doubled the odds of having already used GenAI in class. Expectations ($B = 0.26$, $SE = 0.43$, $OR = 1.30$, $p = .552$) and concerns ($B = -0.44$, $SE = 0.35$, $OR = 0.64$, $p = .207$) were not statistically significant predictors when self-use was included. Model performance was moderate ($AUC = 0.679$; Brier score = 0.18). Figure 4 visualises predicted probabilities of adoption by self-use frequency at median expectations and concerns,

rising from 0.33 (trial only) to 0.86 (almost daily use). Table 4 lists these predicted probabilities by self-use level.

Table 1

Descriptive Statistics, Reliability, and Spearman Correlations Among Key Variables

#	Variable	N	M	SD	α	1	2	3	4	5
1	Expectations	104	3.99	0.64	0.71					
2	Concerns	104	3.39	0.73	0.43	-0.181				
3	Intention	104	4.09	0.81	0.90	0.703***	-0.134			
4	Self-use frequency	102	3.08	0.87		0.606***	-0.218*	0.593***		
5	Classroom adoption	102	0.73	0.45		0.085	-0.111	0.014	0.255**	

Note. Spearman correlations are shown below the diagonal. * $p < .05$. ** $p < .01$. *** $p < .001$. Self-use frequency: 1 = trial only, 2 = monthly, 3 = weekly, 4 = almost daily. Classroom adoption: 0 = no, 1 = yes.

Table 2

Stage 1 OLS Regression Predicting Intention to Use GenAI in Class

Predictor	B	SE	β	t	p
Intercept	0.542	0.509		1.062	.291
Expectations	0.669	0.114	0.524	5.887	< .001
Concerns	0.034	0.082	0.031	0.422	.674
Self-use frequency	0.249	0.083	0.267	3.005	.003

Note. $n = 102$. $R^2 = .500$. B = unstandardized coefficient. β = standardized coefficient.

Table 3

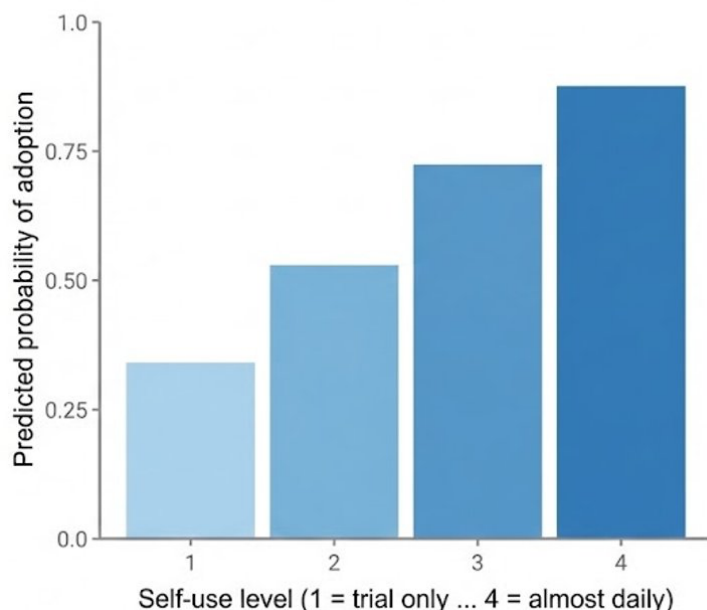
Stage 2 Logistic Regression Predicting Classroom Adoption of GenAI (Yes/No)

Predictor	B	SE	OR	p
Intercept	1.951	2.045	7.040	.340
Expectations	-0.559	0.460	0.572	.224
Concerns	-0.369	0.338	0.692	.275
Self-use frequency	0.845	0.330	2.329	.010

Note. $n = 102$. OR = odds ratio. Model performance: AUC = 0.679; Brier score = 0.182.

Figure 4

Predicted Probability of Classroom Adoption by Self-Use Frequency (at Median Expectations and Concerns)

**Table 4**

Predicted Adoption Probabilities by Self-Use Frequency (Median Expectations = 4.00; Median Concerns = 3.50)

Self-use frequency	Coding	Predicted probability
Trial use only	1	0.325
Monthly use	2	0.528
Weekly use	3	0.723
Almost daily use	4	0.859

Discussion

This study tested a two-stage model of GenAI adoption among Japanese high school Informatics teachers, distinguishing intention from classroom adoption. The findings clarify that determinants of “wanting to use” and “already using” are not identical. Expectations of benefit were strongly associated with intention, while teachers’ everyday self-use frequency was the key predictor of classroom adoption.

Expectations as a Driver of Intention

Expectations were the strongest predictor of intention, supporting the view that perceived usefulness remains central even in GenAI contexts. Teachers appear to form willingness to use GenAI when they expect tangible professional and pedagogical benefits, such as reduced preparation time and richer explanations. This aligns with technology acceptance research in which performance expectancy or usefulness is consistently linked to behavioural intention (Venkatesh et al., 2003). Informatics teachers may have particularly salient expectations

because GenAI can support tasks central to Informatics teaching, including generating alternative examples, debugging code, or preparing data-related exercises. The descriptive results also show that most respondents already use GenAI for lesson preparation and information search, suggesting that usefulness is not hypothetical for many teachers but grounded in lived experience.

Self-Use as a Bridge to Adoption

Self-use frequency predicted both intention and, more importantly, classroom adoption. Even when expectations were controlled, self-use remained the only significant predictor of whether teachers had already used GenAI in class. This pattern is consistent with the idea that classroom adoption requires more than positive beliefs; it requires practical fluency, routines, and confidence in managing risks in front of students. In practical terms, teachers who regularly use GenAI for lesson planning, material preparation, or administrative tasks may develop (a) prompting strategies that produce useful outputs, (b) habits of checking and revising outputs, and (c) a sense of feasibility that lowers the threshold for trying GenAI with students. Self-use may also expose teachers to both strengths and limitations of GenAI, allowing them to design classroom tasks that leverage benefits while constraining risks. This interpretation is consistent with recent research emphasising teachers' GenAI self-efficacy, valuing, and integration at work (Collie et al., 2024) and with evidence that teachers' intention to use GenAI is related to their AI literacy and confidence (Kong et al., 2024). Importantly, the present findings suggest that self-use is not merely correlated with favourable attitudes; it may be a practical mechanism that helps teachers cross the threshold from interest to implementation.

Why Concerns May Not Statistically Distinguish Adopters

Concerns did not predict intention or adoption once expectations and self-use were included. This should not be interpreted as indicating that concerns are irrelevant. Rather, several interpretations are plausible. First, concerns may be pervasive across the sample, reflecting the broader policy environment in which many educators are aware of risks related to accuracy, ethics, and governance. If both adopters and non-adopters share similar concerns, the statistical model will not treat concerns as a differentiating factor. Second, the concerns scale in this study combined qualitatively different elements: epistemic concerns about output accuracy, normative concerns about ethics and copyright, and institutional concerns such as blocked access. The low internal consistency ($\alpha = .43$) supports this heterogeneity. Some concerns may inhibit adoption (e.g., strong access restrictions), while other concerns may coexist with adoption because they are managed through mitigation strategies (e.g., verification routines). This aligns with the observation that many adopters reported teaching ethics and copyright as part of their classroom implementation, suggesting that concern can be transformed into curricular content rather than a barrier. Third, concerns may function less as predictors of "whether to adopt" and more as determinants of "how to adopt." MEXT guidance emphasises responsible use under human oversight, including explicit checking of outputs and attention to ethical issues (MEXT, 2024). Informatics teachers may be especially prepared to operationalise concerns into classroom rules and learning activities because information ethics and critical evaluation are already curriculum-relevant.

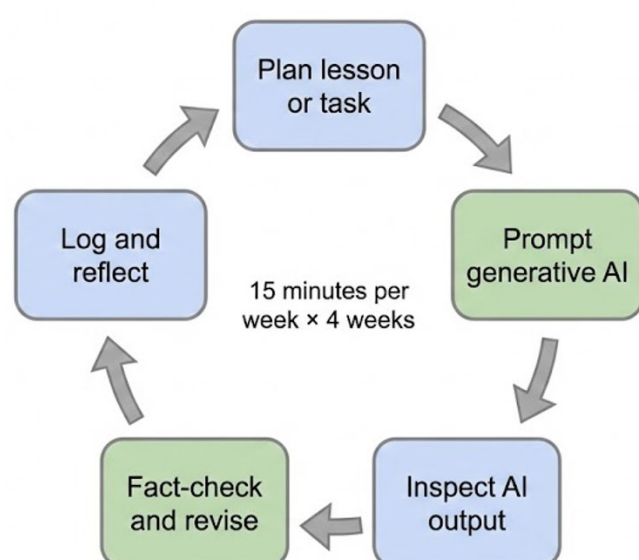
Implications for Professional Development

The two-stage findings imply a practical sequence for supporting adoption. If expectations generate willingness but self-use enables enactment, then PD should prioritise building safe,

repeatable self-use routines before expecting broad classroom integration. From a design perspective, this calls for PD that is short, authentic, and routine-forming. One feasible model is a short practice loop that respects teachers' time constraints: for example, 15 minutes per week for four weeks. In each cycle, teachers use GenAI for an authentic task (e.g., drafting an explanation, generating quiz items, or creating alternative examples), then check outputs for accuracy and appropriateness, revise key parts, and briefly document prompts and changes. Over repeated cycles, teachers can accumulate a small repertoire of high-quality prompts, examples of output failure modes, and concrete strategies for verification. Because this routine focuses on teachers' own work, it avoids immediate student-risk exposure while still building the competence needed for later classroom trials. Figure 5 illustrates this short practice loop.

Figure 5

Short Practice Loop for Building Teacher Self-Use Routines (15 Minutes per Week $\times$ 4 Weeks)



Implications for School-Level Guidelines and Classroom Rules

At the school level, concerns can be translated into simple, checkable rules that support responsible classroom practice. Based on common concerns reflected in policy debates and teacher reports, three rules are especially actionable: (1) disclosure—students should be told when GenAI has been used in lesson materials or tasks; (2) source awareness—key factual claims should be accompanied by sources, references, or explicit verification steps; and (3) a short checking log—teachers and students should keep brief notes on how outputs were checked and revised. These rules align with governance recommendations that emphasise transparency, accountability, and information literacy (OECD, 2023; MEXT, 2024). For Informatics education, these rules can be embedded as learning objectives rather than imposed solely as compliance requirements. Teaching students to disclose AI use, verify claims, and document checking steps directly supports information-utilisation competency and AI literacy. Moreover, because many teachers already use GenAI for lesson preparation and information search, such rules help ensure that GenAI-related risks are addressed consistently in both teacher work and student learning. These rules are summarised in Figure 6.

Figure 6*Three Simple, Checkable Classroom Rules Derived From Common Concerns***□ Disclosure**

Tell students when AI has been used.

□ Show sourcesShow sources or references for
AI-assisted content**□ Keep a short checking log**Record how AI output was checked
and fitted**Theoretical Contribution**

Conceptually, the two-stage model clarifies that determinants of intention are not identical to determinants of adoption. Expectations predicted “wanting to use,” while self-use predicted “already using.” For research on teacher GenAI adoption, this distinction suggests that models focused solely on intention may overestimate readiness for implementation, especially in contexts where classroom use requires careful governance and verification routines. Future studies could extend the present approach by incorporating facilitating conditions (e.g., school access and device policies), teacher GenAI self-efficacy, and student-related factors such as assessment integrity concerns. Methodologically, separating adoption from implementation quality (e.g., depth of student engagement, openness of tasks, and integration with ethics instruction) would also allow more fine-grained understanding of how teachers move from initial trials to sustainable practice.

Interpreting the Intention-Adoption Gap and Model Performance

A notable descriptive pattern is that intention was only weakly correlated with classroom adoption, while self-use frequency was more strongly related to adoption. Although the logistic model’s predictive performance was moderate ($AUC = 0.679$), it leaves substantial variance unexplained. This is expected in school settings where adoption depends on factors beyond individual perceptions. Facilitating conditions such as whether GenAI sites are blocked on school networks, whether student device use is permitted, and whether a school has clarified rules for privacy and academic integrity may critically shape whether a teacher can implement GenAI even when motivation is high. Similarly, adoption may depend on teacher role expectations (e.g., being responsible for digital governance in the school), local community attitudes, and the perceived consequences of mistakes. The modest AUC therefore reinforces the value of treating adoption as a multi-level phenomenon: individual self-use may provide a personal bridge, but institutional conditions still matter.

From Intention to Safe Enactment: A Staged Implementation Pathway

The descriptive activity patterns reported by adopters suggest that early classroom adoption often takes a staged form: teachers begin by explaining what GenAI is, demonstrating its outputs, and discussing ethics and copyright before moving to open-ended student use. This staged pathway can be formalised into an implementation sequence that reduces risk while building student competencies. Stage A (teacher-facing preparation) focuses on teacher self-use. Teachers use GenAI for planning and material development while applying verification routines (e.g., cross-checking key facts, rewriting sensitive content in their own words, and

removing personal data). Stage B (teacher-led classroom demonstration) introduces GenAI to students through controlled demonstrations, where the teacher models prompting, detects errors, and shows how to correct or reject outputs. Stage C (structured student use) allows students to use GenAI within clearly defined constraints: tasks specify what is allowed (e.g., idea generation, code debugging) and what is not allowed (e.g., submitting unedited GenAI output as final work), and students are required to document prompts and verification steps. Stage D (open-ended integration) is reserved for contexts where students have demonstrated sufficient AI literacy and information ethics, and where assessment design can minimise integrity problems. For Informatics education, this staged pathway can be aligned with existing curricular emphases on information ethics, data utilisation, and computational problem solving. For example, students can compare GenAI-generated explanations with textbook and teacher explanations, identify potential hallucinations, and evaluate the credibility of sources. In programming units, students can use GenAI for debugging but must explain the logic of solutions and cite the interaction. In data utilisation units, GenAI can be used to propose hypotheses or summarise patterns, but students must validate claims with actual data and make reasoning explicit.

Linking GenAI Governance to Information-Utilisation Competency

The governance recommendations in OECD (2023) and the guidance issued by MEXT (2025) share an underlying educational principle: GenAI should not replace human judgement but can be used to strengthen learning when combined with transparency and critical evaluation. This principle aligns closely with the aims of information-utilisation competency in Japan, which emphasises the ability to collect, interpret, and evaluate information and to act responsibly in digital environments. From this perspective, Informatics classrooms can treat GenAI not only as a tool but also as an object of inquiry. Rather than framing GenAI purely as a shortcut or a threat, teachers can position it as a technology whose outputs must be interrogated, contextualised, and ethically managed. Importantly, the present findings suggest that teacher self-use may be one practical lever for improving this kind of instruction. Teachers who frequently use GenAI may accumulate concrete examples of both productive uses and failures (e.g., confident but wrong answers), which can be turned into teaching materials that cultivate students' critical evaluation skills. PD that supports teachers in collecting and curating such examples—along with prompts and verification steps—may therefore contribute to both adoption and instructional quality.

Measurement Implications

Finally, the results highlight a measurement challenge. Concerns about GenAI are not a single construct; they include epistemic risks (accuracy and bias), normative risks (copyright and plagiarism), and institutional constraints (blocked access and unclear rules). Future research should separate these dimensions and examine which types of concern predict intention, which predict adoption, and which predict implementation quality. Such refinement would allow PD and policy to target the concerns that are most actionable in practice, rather than treating “concerns” as a uniform barrier.

Limitations and Future Work

This study has several limitations. First, the sample was a voluntary national sample and may overrepresent teachers who are already interested in GenAI or who have access to professional communities where GenAI is discussed. Second, the design was cross-sectional, so causal

ordering cannot be established. It is plausible that early classroom adoption also increases later self-use frequency, and longitudinal data are needed to test directionality. Third, measures were self-reported and did not include classroom observations or artefact analysis. Fourth, classroom adoption was measured as a single binary indicator and did not capture quality, depth, or student outcomes. Finally, the concerns scale combined multiple concern types and showed low internal consistency, suggesting that future work should differentiate ethical, epistemic, and institutional concerns.

Future research should therefore use longitudinal and intervention designs. One promising direction is to evaluate the short PD practice loop proposed above, measuring changes in self-use, verification habits, and classroom adoption over time. Such studies could also test whether PD that targets verification routines reduces risk-related incidents (e.g., use of inaccurate outputs) and increases teachers' confidence in managing student use. Cross-country comparative studies would clarify which aspects of the two-stage model generalise across curricula and governance environments. Within Japan, further work should examine differences across subjects beyond Informatics and should refine measurement of concerns by separating ethical, technical, and institutional dimensions.

Conclusion

In Japanese high school Informatics education, teachers' decisions about GenAI matter because the subject is compulsory and directly connected to information literacy and data utilisation. Using a two-stage model, this study found that expectations of benefit strongly predict teachers' intention to use GenAI, while everyday self-use frequency is the key predictor of whether teachers have already adopted GenAI in class. These findings suggest a practical sequence for bridging policy and classroom practice: build self-use routines first through short, authentic PD cycles, and support implementation through simple, checkable classroom rules that address transparency and verification.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author used OpenAI's ChatGPT to support English drafting and to improve language and readability. The author reviewed, revised, and approved all substantive content, analyses, interpretations, and the final wording, and takes full responsibility for the paper.

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Contact email: s.inagaki@yamanashi.ac.jp

Enhancing Education in Disaster Management With the Responding Lab

Thomas Säger, TH Köln – University of Applied Sciences, Germany
Lennart Landsberg, TH Köln – University of Applied Sciences, Germany
Konrad Barth, TH Köln – University of Applied Sciences, Germany
Niklas Tschäschke, TH Köln – University of Applied Sciences, Germany
Ompe Aimé Mudimu, TH Köln – University of Applied Sciences, Germany

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Abstract

This article presents innovative training concepts in disaster management with the Cologne Responding Lab (CRL), emphasizing the integration of theoretical instruction with practical application. A “learning by doing” approach fosters experience-oriented learning, developing both subject expertise and key skills such as teamwork, resilience, and problem-solving. Instructors with practical experience in risk management, crisis response, and emergency medicine supervise students during realistic deployments, enabling rapid qualification and role differentiation. Student feedback is collected and external reviewers evaluate the program, which is highlighted for its strong practical focus. The CRL acts as a bridge between emergency responders and leadership researchers, facilitating knowledge transfer. For example, after the devastating flood in the Ahr Valley, CRL supported the construction of a temporary bridge using video technology, enabling the Federal Agency for Technical Relief to relocate its On-Site Operations Coordination Centre to a safer location. This approach prepares personnel to perform complex tasks such as situation assessment and coordination. The Institute for Rescue Engineering and Civil Protection (IRG) fosters collaboration between science and civil protection by applying current research to practice through large-scale exercises and real deployments, ensuring academic training evolves with disaster management challenges. TH Köln established a Commission on Responsibility in Science, involved since CRL’s founding, ensuring data safety and participant well-being. The concept relies on strong networks with first responders. Despite high initial costs, IRG’s 15 years of research provide necessary expertise and connections.

Keywords: digitalization, disaster management, drone technology, research transfer, higher education

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Introduction

Emergencies and crises are often complex, dynamic, and time sensitive. Due to the nature of emergencies, leaders must make decisions based on diffuse information. Command systems and tools are meant to support them in this. Command systems are undergoing a fundamental renewal through advancing digitalization.

Large parts of the integrated civil protection system in Germany fall under the legislative competence of the federal states and are the responsibility of local authorities. These structures sometimes complicate the adoption of technological advancements and innovations, such as the widespread general digitalization progressing in many areas. Particularly in the management of large-scale damage situations, there would also be a need for standardizing interfaces and tactical frameworks (Bundesministerium des Innern, 2023; Sauerland et al., 2020).

Cologne Responding Lab

Cologne University of Applied Sciences (TH Köln) operates a laboratory for large-scale incidents. For over 15 years, this laboratory has been conducting research projects focusing on large-scale disaster situations. As part of these projects, large-scale exercises are regularly carried out and scientifically evaluated.

Since 2024, TH Köln has established an organizational structure to support emergency response forces in real-world disaster situations. For this purpose, the Institute of Rescue engineering and Civil Protection (IRG) founded the Cologne Responding Lab (CRL). The CRL at Cologne University of Applied Sciences exemplifies how TH Köln integrates practical experience and scientific research to enrich teaching and create direct societal benefits.

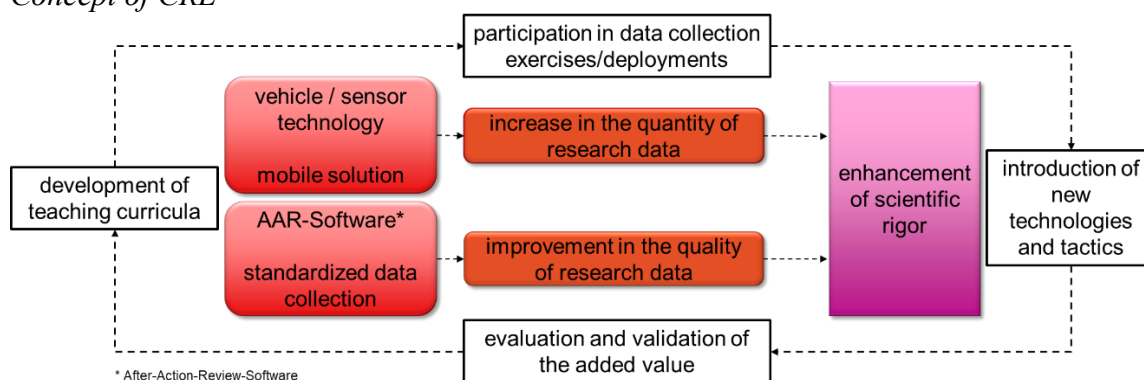
Figure 1

The System of Responding Lab: Vehicle and Container With Drones and Modern Measurement and Communication Technologies



The Cologne Responding Lab promotes the exchange between science and emergency services to translate current insights into applicable concepts. Activities such as participating in large exercises and real deployments augment the research, while results and data are made available to users.

Figure 2
Concept of CRL



Transformative Teaching

The IRG actively contributes to an open transfer of knowledge with society. Both society as a whole and the students benefit from a shift in perspectives through the active integration of real-world labs in teaching. This approach enables students to develop hardware and training concepts, for example, for fire safety education or to support local disaster management.

Figure 3
CRL at Local Fire Department



Figure 4
Deployment of CRL



The CRL consistently relies on the “learning by doing” philosophy, considered the core of modern training and professional development in disaster management. The goal is not to impart theoretical knowledge in isolation, but to apply it directly in a realistic, practice-oriented environment. Learning thus becomes an experiential process that strengthens not only professional expertise but also key competencies such as teamwork, resilience, and problem-solving. This didactic approach enables learners to test and further develop their knowledge in a safe yet authentic environment.

Impact

The exercises at the CRL are not only based on theoretical knowledge but also draw directly on current, real-world disaster situations. For example, the CRL supported the Federal Agency for Technical Relief (THW) in relocating its command team during the construction of a temporary bridge after the flooding in the Ahr Valley by developing and testing technical

solutions for video transmission during operations. This direct link between real-world deployment and training raises awareness of the complex challenges of crisis management. Participants experience complex situations that they must actively structure, assess, and coordinate, such as the establishment of temporary infrastructure after natural disasters. In addition to technical aspects, participants hone their decision-making skills and leadership experience. Continuous support from experienced instructors enables thorough reflection and immediate feedback. This is complemented by comprehensive feedback from participants and external evaluations, which ensure the continuous improvement of the training programs.

Figure 5

CRL Integrated Into the Incident Command Post



Figure 6

Fully Erected Temporary Bridge



Another practical example of combining technical expertise and leadership skills is the conversion of two Ford Transit vans by CRL students. These vehicles were equipped with a fully functional workstation, including a chartplotter, video transmission hardware, and server technology. In doing so, the students acquire classic engineering skills such as planning, installing, and maintaining complex technical systems. Simultaneously, they develop leadership qualities by independently handling cross-team coordination, project management, and decision-making within the technical conversion process. This approach not only provides participants with outstanding technical qualifications but also strengthens their role as

multipliers—many of them volunteer in disaster relief and thus directly apply their newly acquired skills to their units and their professional lives. This significantly contributes to societal resilience, as well-trained specialists and leaders enable effective and coordinated crisis management.

Figure 7

Ford Transit Interior Fittings



Conclusion

The responding Lab offers an opportunity to complete a technology transfer into emergency management while allowing scientists to be safely integrated as spontaneous helpers in real damage situations. A new research project entitled Protego is already in the application phase.

The CRL exemplifies how “learning by doing” better reflects the complex demands of modern disaster management than purely theoretical training concepts. Through targeted practical exercises under realistic conditions, participants are empowered to act quickly, flexibly, and in a coordinated manner in an emergency. The intensive integration of theory and practice not only creates technical qualifications but also a deep understanding of operational challenges and leadership tasks.

One of the major challenges in implementing the “learning by doing” approach at the CRL is the high cost of acquiring and operating the technical equipment and the complex training scenarios. Furthermore, to ensure the safety of participants, the involvement of an external body, such as an ethics committee, is essential. This committee ensures that no physical or psychological strain occurs during use and that all ethical guidelines are followed. In the case of TH Köln, the IRG benefits from its many years of expertise and a broad network of partners, which enables reliable third-party funding. Moreover, the positive public image of the CRL has attracted various sponsors who support the concept. The well-being of participants and compliance with data protection and other ethical considerations are consistently ensured at the IRG through close collaboration with the Commission for Responsibility in Science at TH Köln.

A concept for a SEG (Rapid Deployment Unit) research unit is to be developed. This way, other universities could follow the example of TH Köln.

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Contact email: ompe_aime.mudimu@th-koeln.de

Collaborative Online International Learning: Connecting Chilean and American University Students Through Journalism-Based Virtual Exchange

Nicole A. Porcaro, Montgomery College, United States

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Abstract

Collaborative Online International Learning (COIL) is an instructional approach that connects geographically distant students and instructors through technology-mediated collaboration, enabling intercultural learning experiences embedded within existing coursework to create empathetic, informed global citizens. This paper reports on a COIL project implemented within a college-level English 101 course at a community college in the United States in partnership with two universities in Chile. Using a journalism-based unit, students engaged in cross-cultural interviews and collaborative inquiry, culminating in human-interest articles and multimedia reflections published in a shared digital space. The project was guided by the Association of American Colleges and Universities (AAC&U) Intercultural Knowledge and Competence VALUE rubric and emphasized curiosity, empathy, intercultural communication, and global awareness as key focus areas. The instructor employed a mixed-methods research design. Pre- and post-survey data were collected using Microsoft Forms from 13 American students (100% participation) and 5 Chilean students (30% participation). Quantitative findings indicated gains across multiple intercultural competence indicators, including increases in cultural knowledge and worldview awareness (approximately 14%), intercultural communication and empathy (approximately 5–6%), and attitudes of openness and curiosity (ranging from 3% to 18.5%, depending on the metric). Qualitative analysis of student reflections and open-ended survey responses further demonstrated growth in empathy, cultural awareness, and appreciation for global perspectives. Findings suggest that journalism-centered COIL projects can effectively support global learning outcomes in community college and early-college contexts while remaining scalable and adaptable across disciplines and secondary education age groups.

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Introduction

Institutions of higher education, including community colleges, increasingly seek pedagogical models that promote global learning and intercultural competence while remaining accessible to diverse student populations. Collaborative Online International Learning (COIL), pioneered through the SUNY COIL Center, has emerged in recent years as a promising approach to on-campus and out-of-the class internationalization, allowing students to engage meaningfully with peers from other countries without the financial and logistical barriers associated with physical mobility. COIL is defined as a bilateral, technology-mediated exchange embedded within existing courses across two or more institutions, emphasizing collaborative learning, intercultural dialogue, and curricular integration (Rubin & Guth, 2015).

This paper examines the design, implementation, and outcomes of a COIL project connecting students in the United States and Chile through a journalism-based instructional unit. The project sought to address both global learning objectives and discipline-specific outcomes, integrating intercultural exchange into an English composition curriculum while supporting English-language development (oral and written) for Chilean participants. By situating intercultural collaboration within journalistic inquiry and storytelling, the project aimed to foster curiosity, empathy, and critical thinking while strengthening research, writing, source vetting and communication skills.

Literature Review

Collaborative Online International Learning (COIL) and related virtual exchange models are grounded in theories of collaborative learning, experiential learning, and intercultural competence development. According to the SUNY COIL homepage, “COIL Collaborations are developed by partnering professors from different institutions who want to enrich their courses with student interaction and collaborative learning” (coil.suny.edu). Rubin and Guth’s *The Guide to COIL Virtual Exchange* provides one of the most widely cited foundational texts for understanding COIL as a pedagogical framework. Rubin and Guth (2015) define COIL as a bilateral, technology-mediated exchange embedded within existing courses across institutions, emphasizing sustained collaboration between faculty and students rather than one-time virtual interactions. Central to their framework is the integration of intercultural learning outcomes directly into course design, ensuring that global engagement is treated as a core component of the curriculum.

Rubin and Guth (2015) further position COIL as a key strategy for internationalization-at-home, particularly in contexts where study abroad opportunities are limited by cost, accessibility, or student demographics, or, in the case of community colleges, not offered at all. By leveraging familiar online tools, COIL repurposes digital learning environments to foster intercultural dialogue, shared knowledge construction, and reflective practice. Prior research cited in their work suggests that when virtual exchanges are carefully scaffolded, students demonstrate gains in cultural self-awareness, perspective-taking, and communication skills, especially when exchanges are sustained over time and supported by structured reflection. Additionally, students feel more engaged with what they’re learning, leading to increased participation and confidence.

In addition to its pedagogical potential, COIL scholarship has increasingly examined issues of equity, power, and faculty labor within virtual exchange initiatives. Figarotti, Subbarao, and Bagatella’s article, *An Unspoken Truth: Faculty (In)Equity in the Context of Invisible Violence*,

highlights how structural inequities can shape COIL partnerships. The authors argue that while virtual exchange is often framed as inherently equitable and positive for all parties, disparities in institutional resources, workload expectations, and recognition of faculty labor can reproduce forms of “invisible violence” within international collaborations. This perspective is particularly relevant for projects involving community colleges and institutions in the Global South, where differences in institutional capacity, compensation arrangements, and student participation requirements may affect project implementation.

Together, these works underscore the importance of intentional design, transparency, clear communication, and reflexivity in planning, developing, implementing, revising, and reporting on COIL projects. They suggest that successful virtual exchanges such as COIL require not only technological infrastructure but also careful attention to communication styles, curricular alignment, faculty collaboration, and ethical partnership-building. In response to these considerations, the present study embeds intercultural learning objectives within a journalism-based instructional unit and acknowledges structural constraints—such as uneven participation and differing institutional expectations—rather than treating them as incidental challenges. Further post-study research and reporting will focus on instructor communication methodology, strengths, challenges, and evaluation.

Assessment of intercultural learning outcomes in COIL contexts is frequently guided by the Association of American Colleges and Universities (AAC&U) Intercultural Knowledge and Competence VALUE rubric. The rubric operationalizes intercultural competence across three core domains: attitudes (curiosity and openness), skills (intercultural communication and empathy), and knowledge (cultural self-awareness and worldview frameworks). Prior studies (Association of American Colleges and Universities, 2016; Wade et al., 2022) employing the VALUE rubric emphasize that measurable, meaningful gains in intercultural competence are most likely when students engage in substantive, sustained interaction with culturally different peers and are prompted to reflect critically on those interactions.

By situating the present COIL project within the theoretical frameworks articulated by Rubin and Guth and the critical equity lens advanced by Figarotti et al., this study contributes to the growing body of scholarship examining how virtual exchange can be implemented realistically, responsibly and effectively in diverse educational contexts. Despite growing interest in COIL, limited research has examined its application in community college and Early College settings, particularly through discipline-specific pedagogies such as journalism. While other studies have focused on the concept of “online journalism” in international virtual collaboration spaces (Larrondo et al., 2021), there are currently no published studies on COIL-specific journalism-based projects. This project addresses that gap by demonstrating how technology-mediated interviewing and storytelling paired with inquiry-based collaboration can function as impactful tools to help shape students into global citizens. The journalism-centered design further extends existing literature by demonstrating how discipline-specific pedagogies can serve as vehicles for intercultural learning, particularly within community college and Early College environments. Journalism pedagogy, with its emphasis on inquiry, ethical storytelling, source evaluation, and audience awareness, aligns naturally with COIL’s focus on dialogue, perspective-taking, and meaning-making across cultural contexts. When supported by digital platforms, journalism-based COIL projects leverage technology not merely as a delivery mechanism but as a catalyst for global learning and intercultural engagement, creating end-of-project deliverables that resonate with relevance and skill-building capabilities far beyond the completion of the COIL unit.

Project Context and Design

The COIL project was implemented during a fall academic term within an English 101 course at a suburban community college outside Washington, D.C. (U.S.A.) serving a diverse, majority-minority student population; over half of the student body identifies as African American or Hispanic. Participants included 13 American students enrolled in an Early College cohort program (ages 16–17) and concurrently enrolled in secondary education. Partner institutions included two Chilean universities—a large technical institute and a regional public university—whose students participated voluntarily as part of their English language learning efforts.

Project goals differed slightly by institution while remaining complementary. For American students, objectives included developing cultural competency, practicing journalistic research, interview, and composition skills, and cultivating global citizenship and critical thinking. For Chilean students, the primary focus was improving spoken and written English proficiency within an authentic academic context. Shared goals included navigating intercultural communication through digital platforms, problem-solving across linguistic and cultural differences, and producing collaborative, public-facing work.

The instructional unit centered on cross-cultural interviews and human-interest storytelling. An initial lecture on journalism tenets, terms, and sources, as well as background on Chile, was attended by both American students (in-person) and Chilean students (via Zoom). After this introduction, students were paired across institutions and introduced to one another through a shared digital platform. Over approximately two and a half weeks, students collaborated twice during in-class Zoom meetings, complemented by out-of-class texting and Zoom communication, to plan and conduct interviews, research cultural contexts, and draft journalistic narratives. One additional lecture was provided after the first meeting, also attended by both groups of students. Final products included written articles and short video reflections published on a shared Padlet site functioning as an online magazine.

Methodology

A mixed-methods practitioner research design was employed to assess the impact of the COIL project on student learning outcomes. Data were collected through pre- and post-surveys administered via Microsoft Forms. Surveys included Likert-scale items aligned with the AAC&U Intercultural Knowledge and Competence VALUE rubric as well as open-ended questions designed to elicit qualitative reflections.

Participants included all 13 American students enrolled in an English 101 course (100% response rate) and 5 Chilean students (approximately 30% response rate). Surveys were administered to American students prior to project implementation in mid-October and following project completion in mid-November. Chilean students completed a post-project survey only, due to differences in curricular control and participation requirements.

Quantitative data were analyzed descriptively by comparing pre- and post-survey averages and calculating percentage changes across key metrics. Qualitative data were analyzed thematically, with student responses coded for recurring themes related to cultural awareness, empathy, communication strategies, and perceived value of the exchange.

Findings

Analysis of pre- and post-survey data from American students revealed measurable gains across all assessed domains of intercultural competence. Average scores related to cultural knowledge and worldview awareness increased by approximately 14%, indicating improved understanding of global contexts and cultural frameworks, particularly related to politics, history, beliefs, values, economics, and communication styles of members of other cultural groups. Additionally, students who actively seek to improve their understanding of similarities and differences between cultures also increase 14%. Measures of intercultural communication and empathy demonstrated gains of approximately 5–6%, suggesting moderate but meaningful development in students' ability to interpret and respond to perspectives different from their own.

Attitudinal measures related to openness and curiosity showed variable but notable increases, ranging from approximately 3% to 18.5% depending on the specific item. It should not be discounted that the reason some questions related to openness and curiosity only showed small gains is that Montgomery College has a diverse racial, ethnic, and geographic population, with a high percentage of students coming from immigrant families; therefore, it can be hypothesized that these skills were already present in many students. The largest gains were observed in students' reported willingness to ask questions about other cultures (18.5%) and to engage collaboratively with culturally different peers (9.1%).

Qualitative Results

Qualitative analysis supported and enriched the quantitative findings. Pre-project responses from American students often reflected limited prior knowledge of Chile's geography, culture, population, and history, as well as included generalized assumptions. Pre-survey responses demonstrating this limited knowledge included:

- "I don't really have any general impressions of Chileans, because, if I am being honest, I didn't even know the country existed until this class."
- "They are South American but that's about all I know."
- "I don't have any [impressions of Chile] except that they make good food."
- "I have a friend from Chile; however, he was born and raised in the U.S., so he has no Chilean cultural values."

Students were, however, interested before the project started in trying to make connections between their cultures and Chilean culture. Response demonstrating this included:

- "People from both my culture and the Chilean culture speak Spanish."
- "My culture shares the Catholic belief with Chile. Soccer is also a shared interest, as well as being very family-oriented."
- "Based on my understanding, they have very strong family ties and a lot [of] respect for their elders. The same goes for us, we are known for our hospitality and for always respecting and prioritizing our elders."

Post-project reflections from the American participants, in contrast, demonstrated increased cultural awareness, empathy, and nuanced understanding of social, historical, and educational contexts. Students frequently referenced learning about daily life, educational systems, occupations, and historical events in Chile, as well as gaining appreciation for the challenges of learning and communicating in a second language.

For instance, one student reflected on culture's influence on value systems:

Speaking with students from Chile helped me see how cultural context shapes people's values, priorities, and daily experiences. For example, I noticed differences in how we approach education, social life, and communication, which made me reflect on my own assumptions and broaden my understanding of global perspectives.

Another student remarked on how their perspective was affected:

This experience allowed me to gain insight into what living in another country might look like. I already knew that other countries are different from the U.S., but this experience allowed me to actually experience how different things are. I gained perspective on the way gender plays a role in Chile and the way it plays in the U.S.

Language appreciation was also mentioned as a key gain from this experience:

I always knew learning a new language was hard but it taught me a lot to see how they're learning English and how hard they're working on it.

Students also displayed an increased knowledge of Chilean cultural values, as well as curiosity to learn more:

- "I see Chile as a place full of kind and hardworking people who are a lot like us."
- "I have a lot of newfound respect for the country and its people. I had no idea the true extent of the country's dark history and am glad it's now a safe place to live for Chileans and immigrants."
- "I could know more about the past political regime. The 1973 coup is something that I had never heard about and I could know it through the COIL experience. Consequently, I searched more about the topic as well."

Students also emphasized the development of empathy and patience in navigating language barriers, noting that collaborative problem-solving and flexibility were essential to successful communication, actively reflecting on intangible skills they developed, such as empathy, sensitivity, and mindfulness:

I try to act in a supportive way that recognizes the feelings of other cultural groups by being mindful of the way they might perceive things and being patient with what they might not know... COIL enhanced this for me because I was able to be patient with my partners and recognize when they were struggling with their English. I was able to act in a supportive way and let them know they can take all the time they need.

Apart from each person being sensitive to different aspects of their own life, recognizing how someone else feels about their cultural group is a big part of empathy. I find it crucial to read a person's body language to analyze signals that may not be communicated through what they say... When a person shares their story, they are being vulnerable with you, and the least you can do is be respectful towards their feelings.

Through this project it was frustrating at times trying to get good answers from my partners since we couldn't properly understand each other, but through trial and error we found methods of communication that allowed for us to work together and

understand each other... I never once faulted them for not being able to understand me since I was constantly empathizing with their side of the situation.

In the COIL experience, I read the article [about an earthquake in Chile] which talked about a family that stayed in their country even when it was having a natural disaster, because they wanted to support their community...I was very impressive [sic] with this statement, as it is very hard to see this sense of community among other countries.

Many participants reported increased motivation for future intercultural engagement and expressed support for expanding similar virtual exchange opportunities. Students were expressive about the benefits they gained from this project, especially concerning social and emotional intelligence skills:

The main benefits are gaining a broader worldview and building empathy. Talking with students from another country challenges assumptions, encourages curiosity, and helps me see issues from multiple perspectives. It also improves communication skills and cultural understanding, which are valuable for both personal growth and future professional experiences.

...hearing from university students from another country is a unique way to get to know new people...most of us do not have the chance to talk to people from other countries, but interacting with people the same age as us is even more special. There are things to connect on, but also learn about each other, and I think it creates memories that last longer than traditional icebreakers.

I made some new friends! I've spoken a little with my partner after the project and think it would be cool to visit in Chile one day. I was also able to practice some of my Spanish speaking and learned about the country from experts, considering they live there.

Students were enthusiastic about the possibility of expanding COIL projects in future classes at Montgomery College, asserting that the project held value in increasing their knowledge, communication skills, and breadth of their perspectives:

...opportunities like this allow students to enhance their knowledge of other countries and allow them to experience and learn from people different from them. It also allows them to grow in skills they need for the future, like communication skills. This experience allows students to get outside their comfort zone and learn something new.

I would definitely recommend it [COIL]. Virtual exchanges are a low-cost, accessible way for students to connect with people from around the world. They help broaden perspectives, encourage cross-cultural learning, and make global issues more relatable. Plus, they provide a unique experience that can't be fully captured in a textbook.

I would recommend that MC [Montgomery College] continue developing cultural exchange opportunities like this in a heartbeat. In our behavioral health and sociology classes we're learning that acknowledging cultural differences is significant so you can better understand the values and life experiences of those different to you.

Chilean participants reacted similarly to their participation in the project, responding in a resoundingly positive way about the impact their work had on their communication and English skills, as well as their preconceptions about American students:

I was surprised by how much the U.S. university students knew about other countries, including Chile. I didn't expect them to be so curious and open-minded. Their interest in our culture and their friendly attitude really surprised me in a positive way.

I really appreciate the opportunity to meet new people in other countries, and I think I can say that I've made a new friend. I'm very happy to be able to share ideas, interests, routines, and projects.

I feel that I've gained new perspectives, because now I feel more confident speaking the language, and it sparked my curiosity to keep learning about their culture.

My impressions of the United States have changed in a positive way...I realized people there can be very friendly and open. I also understood their culture better, and I feel more connected and interested in learning more about the country.

Chilean students overwhelmingly recommended that their universities continue to partner with COIL institutions, citing the impactful real-world experience this project provided them on their higher education journeys:

- I would recommend this opportunity to anyone that can be parto [sic] of it. It helps to be more aware of your level of English and it also give's [sic] you the opportunity to talk to a native speaker.
- Yes, I would definitely recommend the school continue to develop virtual cultural exchange opportunities like this. They allow students to connect with people from other countries, practice another language, and learn about different cultures in a real and meaningful way. It also helps build confidence, empathy, and global awareness. Experiences like this make learning more engaging and open new opportunities for the future.
- Of course. It's always beneficial for students to learn about the world and other cultures, and to practice a foreign language in real-life situations.

Further evidence of the positive impact this project had on the Chilean students was their 100% affirmative response rate in selecting at least one option to the question, "As a result of this experience, would you consider any of the following activities in the future as a means of increasing your intercultural knowledge, skills, and or attitudes to different cultures?" All respondents chose one or more of the following answers:

- Keeping in touch with the U.S. university students they met during the project
- Volunteering their time to work with the American community in Chile
- Traveling to the U.S. in the future
- All of the above

Discussion

Findings from this study align with existing research on COIL and virtual exchange, reinforcing the potential of technology-mediated collaboration to promote intercultural learning when embedded intentionally within coursework. The journalism-based framework appeared particularly effective in encouraging inquiry, perspective-taking, and reflective

storytelling, allowing students to engage with cultural differences through authentic, purpose-driven tasks.

Challenges identified during implementation—including time zone differences, language barriers, competing responsibilities, and late changes to institutional partnerships—also served as learning opportunities. For example, both Chile and the U.S. change their clocks for Daylight Savings Time, but Chile's occurs in September, while the United States' time change occurred in the middle of the project in November; the website "World Time Buddy" proved a helpful resource to input countries and dates to determine exact time matches. Language barriers between the students caused one assigned pair to get off to a rocky start, as the American student thought the Chilean student was laughing at them, while the Chilean student, upon investigation, was nervous about the project, and her laughter was an involuntary reaction. Additionally, compensation packages differed greatly, with the American professor being compensated for her work as a COIL fellow through a formal program at Montgomery College, while the Chilean professors participated voluntarily with no institutional financial support. Finally, the original project was between Montgomery College and DUOC, but a day before the project was supposed to launch, DUOC brought on another university, Universidad de Bio-Bio, which caused some last-minute reshuffling to the partnerships. Addressing these challenges required adaptability from both instructors and students and highlighted the importance of clear communication, scaffolding, and institutional support. Ultimately, these challenges proved minor and did not impact the implementation of the project in any major way; in fact, by adding additional Chilean students, many of the American participants were able to engage with multiple interlocutors, contributing to richer, more multifaceted projects.

The project's implementation within an Early College and community college context highlights the accessibility of COIL as a global learning strategy for students who may not otherwise have opportunities for international engagement. At the same time, limitations such as small sample sizes and uneven participation as well as unequal compensation among international partners should be considered when interpreting results. Further study with larger sample sizes and across disciplines other than English is recommended.

Conclusion and Implications

This study demonstrates that journalism-centered COIL projects can effectively foster intercultural competence, global awareness, and communication skills among undergraduate students in diverse educational contexts. By integrating virtual exchange into existing curricula, institutions can provide meaningful international learning experiences that are scalable, cost-effective, and inclusive.

Implications for practice include the value of extended project timelines, increased pre-project cultural preparation, and explicit instruction in intercultural communication strategies. Future iterations of the project may expand participation, incorporate additional disciplines, and explore longitudinal impacts on student learning. As higher education continues to prioritize global learning and equity, COIL offers a flexible and impactful model for connecting students across borders through collaborative, inquiry-based pedagogy.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

Artificial intelligence assisted in language refinement for this paper, but abstract creation, literature review research, project creation, qualitative and quantitative research, data analysis, and Slides presentation were completed solely by the author of this paper.

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Jazz Education in Contemporary Shanghai: Informal Learning and Identity Status Among Secondary Students

Liu Yufei, Hong Kong Baptist University, Hong Kong

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Abstract

Since the early twentieth century, Shanghai has sustained a vibrant jazz ecosystem that continues to shape school music education and young people's perceptions of musical identities. Although many papers indicate that popular music pedagogy is not encouraged in Chinese schools, a year of involvement in an international school in Shanghai revealed abundant popular music activities—especially in jazz—offered informally within the school context. This study aims to examine how integrating informal jazz learning into a formal international school context in Shanghai influences equitable access, participation, recognition, outcomes, and students' musical identity exploration and commitment. Grounded in Erikson's psychosocial theory and Marcia's identity status model, this mixed-methods case study combined year-long observations of school jazz activities with semi-structured interviews with 10 participants aged 16–25 (current students and recent alumni, including school jazz band members, self-identified jazz enthusiasts, and students pursuing jazz degrees in the United States). I analyzed the roles of digital learning, peer learning, and assessment practices in facilitating or constraining engagement and identity work. Findings indicate that informal strategies broadened entry into jazz and supported musical identity exploration; however, limited assessments and uneven recognition from parents and the broader community constrained identity consolidation and access to high-status opportunities. This work addresses a research gap in secondary-school jazz education in Chinese context and has implications for the design of more equitable, identity-affirming music programs.

Keywords: informal learning, musical identity, jazz music education, educational equity, secondary schools

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Introduction

Debates on Informal–Formal Learning in Jazz Pedagogy

Informal learning has long been recognized as a central component of jazz education, where musicians traditionally develop their skills through listening, imitation, experimentation, and active participation in peer-based communities, such as jam sessions and ensembles (Berliner, 2009). Green's (2006) model of informal music learning, derived from the practices of popular musicians, outlines key features that distinguish it from formal music education. These features include learner-selected repertoire, ear-based learning, peer-directed group work, non-linear progression, and a teacher role focused on facilitation rather than direct instruction. Empirical studies across various educational systems suggest that integrating informal learning strategies into formal educational contexts can significantly enhance student motivation, agency, and engagement (de Bruin, 2022; Hewitt, 2018; Mariguddi, 2022; Virkkula, 2016). This fusion of informal and formal learning has been shown to benefit students' creative expression and collaboration (Wright & Kanellopoulos, 2010).

While Green's model of informal music learning has been widely acknowledged, its applicability to jazz education remains a topic of ongoing debate. Green's original research focused primarily on adult white rock musicians, which has led critics to question whether the model's emphasis on popular music is equally effective for jazz, a genre with distinct social and musical practices (Wright & Kanellopoulos, 2010). Additionally, integrating informal learning strategies into jazz education faces challenges, as sustained jazz learning typically requires formal engagement with knowledge, particularly in areas such as music theory and harmony (Virkkula, 2016). In light of these challenges, recent scholars have moved away from the binary distinction between informal and formal learning, instead conceptualizing them as overlapping and mutually reinforcing domains (Hess, 2020; Storsve, 2024). This shift suggests that while informal engagement can ignite initial interest and participation, a balanced approach that incorporates formal knowledge is crucial for sustained and comprehensive jazz education.

Adolescence and the Underrepresentation of High School Jazz Music Education

Alongside these debates, gender disparities in jazz education remain a persistent issue. Female students often report lower confidence and greater anxiety, particularly in jazz improvisation, compared to their male counterparts (Coss, 2018). This gendered experience highlights the intersection of music education and identity formation, an area that has received increasing attention. According to Erikson's (1968) psychosocial theory, adolescence is a crucial stage of identity development, characterized by a struggle between identity formation and role confusion. Frith (2013) further emphasizes that music serves as a social practice through which identities are constructed and recognized. These theories suggest that jazz education, as a social and musical practice, plays a significant role in adolescent identity exploration and commitment.

While existing research on jazz education has predominantly focused on primary school contexts, teacher education, and professional music colleges, there has been limited attention to high school students. This gap is notable because the high school years represent a critical stage for students aspiring to pursue jazz at the university level, where formal knowledge and technical skills are increasingly emphasized. The study of music education in adolescence reveals the importance of identity formation during this period, with students' musical self-

concepts shaped by their educational experiences. Thus, high school is an essential period for exploring how informal and formal jazz learning experiences influence students' musical identities.

Jazz Education in China: Historical and Curricular Contexts

In the Chinese context, jazz has a relatively short history as a formal subject of study. While jazz entered Shanghai's urban popular culture in the 1920s, initially as entertainment for the middle and upper classes (Marlow, 2018), formalized jazz education did not emerge until the early 2000s. Institutions such as the Shanghai Conservatory and JZ School played a crucial role in developing specialized jazz programs. Earlier studies suggested that jazz remained marginal within Chinese secondary school curricula, despite significant student engagement with global popular music cultures (Ho, 2014; Law & Ho, 2015). School music programs in China have traditionally prioritized Western classical and traditional Chinese music, leaving little room for jazz.

However, recent observations suggest a shift in this dynamic. In cities like Shanghai, jazz is now receiving greater institutional support within secondary schools, reflecting a changing educational landscape. The increased exposure to digital music cultures among students has further complicated the divide between classical and popular music in educational contexts. While this change is promising, previous studies, conducted a decade ago, indicated that jazz still faced challenges in the secondary school curriculum. Nevertheless, the present study reveals that jazz is becoming more visibly valued in school-based learning, signaling a need to reassess how jazz is taught and supported within Chinese educational systems.

Research Questions

This study aims to address the following research questions: What informal jazz learning mechanisms are present in this school context? How do these mechanisms enable or constrain students' access to jazz learning and jazz communities? How do students interpret their jazz learning experiences in relation to their musical identity development? These questions are critical in understanding how the intersection of informal and formal learning influences students' engagement with jazz and their development as musicians.

Methodology

Research Design

This study adopted a qualitative research design to investigate informal jazz music learning practices in the secondary school context and their influence on students' perceptions of musical identity. The qualitative approach was considered appropriate because the research sought to explore students' music learning experiences, meanings, expectations, and interpretations of informal learning rather than to measure predefined outcomes. More specifically, this study employed a deductive thematic analysis framework, guided by existing theories, such as informal learning strategies (Green, 2002), identity status (Marcia, 1980), and social recognition in education. This deductive orientation enabled a critical examination of how empirical data aligned with, extended, or challenged established theoretical perspectives.

Settings and Participants

The study was conducted at an international secondary school operating under an American education system. The school offered a diverse music program that included elective courses in music composition, performance, music history, and music technology. In addition to school-based offerings, students were encouraged to pursue external credentials and assessments, such as Advanced Placement Music examinations and online certificates from American institutions, including Berklee College of Music and Harvard Graduate School of Education, especially for those who would like to pursue a bachelor of music degree in the future. The school holds a concert every month to allow students to showcase their latest musical works. The school setting provided a rich site for examining informal learning, as students engaged with jazz across multiple contexts, including formal lessons, extracurricular activities, peer-organized ensembles, and online learning platforms.

Participants included seven male students and three female students who are interested in jazz music from Grade 9 to Grade 12, as well as recent alumni who had graduated from the school and were currently studying music at universities in the United States. The semi-structured interviews aimed to gain perspectives on how high school informal learning experiences influenced musical identity development beyond graduation. Participants were selected through purposive sampling to ensure that they had direct experience with jazz-related learning activities, such as participation in school jazz bands, music clubs, concerts, or external jazz learning programs.

Data Collection

Data were collected through non-participant observations and semi-structured interviews to enhance credibility through triangulation. Observations took place in formal music lessons, after-school clubs, jazz ensemble rehearsals, and performance sessions, focusing on learning behaviors, peer interactions, and informal learning strategies like collaboration, self-directed practice, and improvisation. Interviews asked participants to reflect on campus activities, peer learning experiences, engagement with digital platforms, and future plans. Alumni were prompted to connect past learning with current aspirations and musical identity. Interviews were audio-recorded with consent, transcribed, and integrated with field notes for analysis. Participants were provided anonymity and are identified by participant numbers (P1, P2, etc.).

Data were analyzed using a deductive thematic approach (Braun & Clarke, 2006), guided by theories of informal music learning (Green, 2002, 2017), sociocultural learning (Vygotsky, 1978), and identity development (Erikson, 1968; Marcia, 1980). These frameworks served as sensitizing concepts, directing attention to how learning was structured and valued within the school context. The analysis proceeded in stages, starting with familiarization with the data through repeated readings. Initial coding focused on learning activities, peer interactions, and affective responses. Codes were then reorganized to identify mechanisms shaping access to jazz learning, participation, recognition, and identity. Finally, themes were constructed by grouping related mechanisms, which were refined through iterative comparison across participants and data sources.

Findings

Theme 1: From Informal Practice to Formal Knowledge

In jazz education, learning licks (see Figure 1) is traditionally rooted in informal learning practices such as listening, imitation, and repetition. Students are encouraged to learn these licks by ear from recordings of iconic jazz musicians like Charlie Parker, Dizzy Gillespie, and Bud Powell, reflecting an aural-first pedagogical approach in which sound precedes notation (Berliner, 2009). However, students reported challenges in applying learned licks to live performances, particularly when the harmonic structure changes.

“When I practise, I feel like I need to learn more music theory” (Participant 2, interview, 2024).

“I don’t really know how to use licks when I’m playing” (P7, interview, 2024).

As students progressed, many began to recognize the necessity of music theory for their musical development. This recognition marked a shift from purely informal engagement toward a greater acceptance of formal learning. However, some students struggled with this transition:

“Music theory is too complicated for me” (P6, interview, 2024).

It reflected the challenges many face when confronted with the complexities of formal theory in the context of jazz.

Figure 1

Short ii-V-I Jazz Lick

The figure displays a short ii-V-I jazz lick in G major, 4/4 time, across three systems of notation. The first system is for a standard treble clef instrument, showing the melody with chords ii: D-11, V: G13, and I: Cmaj7. The second system is for an Eb instrument (E major), showing the melody with chords B-11, E13, and Amaj7. The third system is for a Bb instrument (F# major), showing the melody with chords E-11, A13, and Dmaj7. Fingerings are indicated by numbers 1-5 above the notes.

Theme 2: Digital Learning and Expanded Access

Many students come into contact with jazz music because of performances in jazz clubs, which are popular in Shanghai, and recommendations from instrument teachers outside the school, but they have no sense of participation.

“I haven’t actually practiced improvisation. I just like the vibe of the JZ club” (P1, interview, 2024).

“JZ club has a jam session every Sunday evening, but I never go on the stage” (P4 & 5, interview, 2024).

While the formal music curriculum in school is often confined to classical genres and the syllabus set by the teachers, online platforms have provided students with a wider range of music genres, which fills a gap in their school music education. One prominent example of this is the online music courses offered by Berklee College of Music. These courses cover a wide array of jazz music topics, including music theory, composition, and arrangement. The courses provide a certificate upon completion, offering secondary students a valuable credential that could be used to earn university credits if they decide to pursue a related major in the future. Some students expressed pride in receiving the Berklee certificate, seeing it as a significant achievement.

“I’m the only middle school student in the class. The other students are either adults or postgraduates” (P2, interview, 2024).

“I have completed three courses, which many professional jazz musicians may not have learned” (P7, interview, 2024).

However, the cost of these courses was a point of concern even among students from middle class or upper class, as their parents questioned whether the investment was worthwhile.

“I didn’t register because it’s quite expensive. My father is not willing to pay. Actually, similar teaching videos can also be found on YouTube and Bilibili” (P3, interview, 2024).

“I feel it won’t be of much use to my improvisation. I won’t sign up for other courses. They are very expensive” (P5, interview, 2024).

Theme 3: Teacher Mediation and Competency Limits

In the context of jazz music learning, teachers primarily played a mediating role in supporting students’ exploration of musical identity and helping them manage academic responsibilities, rather than directly teaching jazz. Teachers did not dictate specific genres for students to study, but instead guided them toward external learning resources, such as the Berklee online jazz courses, provided feedback on assignments, and monitored progress in performance and theory.

Many students emphasized that teacher support was crucial for navigating both academic expectations and informal learning pathways. One student described this supportive relationship:

“He always reminds me about deadlines, and if I don’t understand something in the online tasks, I go to him for help. He has a PhD in music, and with his help I got As last semester” (P8 & 10, interview, 2024).

“Whenever I didn’t finish an assignment, my mom was informed immediately, and it felt awful” (P9, interview, 2024).

This illustrates how teacher mediation involved a combination of academic supervision and individualized guidance, helping students sustain engagement with jazz alongside formal

schooling. However, students recognized clear limitations in this support, largely shaped by teachers' professional backgrounds. Most teachers were trained in classical music and lacked specialized expertise in jazz beyond basic theory and historical knowledge.

Because of these competency limits, students' primary engagement with jazz occurred outside formal classroom instruction—through online platforms, external instrumental teachers, peer networks, and community music spaces. While teachers shared resources on jazz history and repertoire, students assumed increasing responsibility for directing their own learning:

“I’ve learned more about jazz music from my friends and outside music clubs than I have in school. My music instrument teacher outside of school also recommends great resources” (P4, interview, 2024).

This lack of recognition from both the school system and families complicated students' efforts to consolidate their jazz identities. While teacher mediation and informal learning strategies broadened access to jazz and supported identity exploration, limited assessment mechanisms and uneven recognition constrained students' ability to translate these experiences into stable, institutionally valued musical identities or access higher-status opportunities.

Theme 4: Peer Learning and Participatory Jazz Culture

Peer learning played an essential role in the students' engagement with jazz music, especially given the collaborative nature of jazz performance. Students considered they could find group members easier in school, even they do not share the same music tastes. Sometimes they joined in and feel a sense of belonging.

Before transferring here, I never listened to jazz music. I like pop music and wanted to become a pop singer. But after playing jazz with my friends, I realized it's a whole different level. Jazz is advanced—it requires a deeper understanding of music theory and improvisation. I think it's cooler. (P6, interview, 2024)

Through the academic year, there were totally twelve jazz music bands, with four to seven members for each band. Some students participated in more than one band, while some joined on a one-off basis and quickly left. This peer-based system often led to challenges. Since most of the bands were self-organized and lacked formal constraints, the student groups were fluid and often experienced frequent changes in membership. Additionally, female students reported difficulty developing a sense of belonging in peer groups that were predominantly male.

“I have changed three bands at school, and each time they ended up with arguing” (P3, interview, 2024).

“All members in the band is boys. I just don't want to deal with them” (P9, interview, 2024).

Theme 5: Assessment

In this school, the formal assessment mechanisms—such as grading, feedback on assignments, and performance evaluations—were primarily rooted in the school's classical

music curriculum and did not adequately address the informal, explorative nature of jazz learning. As a result, students' interactions with jazz music were often perceived as peripheral to the formal educational structure, and the recognition of their jazz learning was inconsistent. While the school offered opportunities for students to participate in band and many practice activities, these formal avenues were often seen as separate from the everyday learning that took place in informal settings.

“We do a lot of jazz band rehearsals and performances, but none of that really counts at school. It’s just for fun, and my GPA is still pretty low” (P2, interview, 2024).

“I think going to concerts should count toward our GPA, but that’s just not how the system works” (P3, interview, 2024).

The absence of formal recognition through grades or academic credits led some students to question the legitimacy of their jazz pursuits, even when they were deeply engaged in the music.

However, the potential of alternative forms of assessment, such as digital badges and peer-based evaluations was uncovered. Regular performances also offered social recognition, with some students gaining reputation among peers.

“I am the number one drummer in our school” (P2, interview, 2024).

Theme 6: Identity Exploration and Social Expectations

Participants demonstrated varied stages of musical identity development, with most students situated in the “Moratorium” status (Marcia, 1980). These students were actively exploring jazz as part of their musical identities but had not yet made firm commitments regarding their future involvement in the genre. This exploratory phase was often marked by uncertainty, particularly due to limited access to formal jazz education, unclear professional pathways, and uneven recognition from families and the broader community. Some students occupied the “Foreclosure” status, having committed to jazz without extensive exploration of alternatives. These commitments were frequently shaped by external pressures, including parental expectations and pragmatic considerations about career stability.

I’ve been playing jazz for years, but I never really thought about what it means for my future. My parents always wanted me to study something “stable,” like business. Sometimes I feel like I’m stuck between following my passion for jazz and meeting their expectations. (P5, interview, 2024)

“My mom doesn’t really understand why I’m into jazz. She wants me to focus on classical music” (P10, interview, 2024).

“Jazz musicians earn very little money” (P1, interview, 2024).

Gender further shaped these identity processes. Female students, in particular, described additional challenges in pursuing jazz, a genre historically dominated by male musicians.

“I think women are not very good at music composition and improvisation” (P9, interview, 2024).

“It seems that all the jazz players are boys, while girls can only sing” (P10, interview, 2024)

These pressures heightened uncertainty during identity exploration and made long-term commitment to jazz more difficult, especially for female students.

Discussion

Informal Learning and the Necessity of Music Theory

Students’ engagement with jazz in this study typically began through informal learning strategies such as listening, imitation, repetition, and peer-based experimentation, particularly through learning licks and improvisation by ear, aligning with Green’s (2002, 2017) model of informal music learning and recent research showing that such approaches enhance motivation and engagement in jazz education (Berliner, 2009; de Bruin, 2022; Virkkula, 2016). However, this study extends Green’s framework by demonstrating that music theory learning is not optional in jazz, but essential for sustained participation, especially in ensemble contexts where harmonic understanding and stylistic knowledge are required. Consistent with recent scholarship that conceptualizes jazz learning along a continuum between informal and formal learning (Hess, 2020; Storsve, 2024), students reported reaching a point where informal practice alone was insufficient.

An extended discussion that arises in the study is that this transition to formal theoretical knowledge often occurred without systematic instructional support, as jazz theory was rarely taught explicitly in formal classes. Many students experienced theory as difficult and discouraging when learned independently, which undermined confidence and, in several cases, discouraged them from pursuing jazz or music degrees despite strong initial interest. These findings complicate celebratory accounts of informal learning by highlighting how insufficiently supported theory learning can constrain students’ long-term musical pathways, suggesting that informal jazz learning in secondary schools must be complemented by explicit and supported theory instruction to function equitably.

Digital Learning as Expanded but Unequal Access

Digital learning platforms—particularly online jazz courses and open media resources—played a crucial role in broadening students’ access to jazz knowledge beyond the school curriculum. These platforms offered structured content, exposure to professional standards, and, importantly, formal certificates, which students perceived as valuable cultural capital. In this sense, digital learning aligns with Green’s informal principles by enabling self-directed, interest-driven learning, while also introducing new forms of formalization.

However, access to digital learning was uneven. Financial cost, parental approval, and differing perceptions of value shaped who could participate fully. This finding challenges optimistic assumptions that digital learning inherently democratizes music education. Instead, digital platforms may reproduce existing inequities, privileging students with greater economic and familial support.

Teacher Mediation Beyond Technique

Teachers played a significant, though indirect, role in students’ jazz learning. Most teachers lacked specialist jazz expertise and did not teach improvisational techniques in depth.

Nevertheless, their contribution was essential in three ways: resource provision, emotional and academic support, and monitoring and legitimation. Teachers guided students toward external learning opportunities, helped them manage academic workloads, and facilitated performance opportunities within school concerts.

This mediating role aligns with sociocultural perspectives on teaching as scaffolding rather than transmission. Teachers functioned as brokers between informal learning and formal schooling, enabling students to sustain engagement with jazz despite curricular constraints. However, reliance on individual teacher support also created inconsistencies, as students' opportunities depended heavily on teacher attitudes and capacity. The findings highlight the need to reconceptualize teachers' roles in jazz education—not as sole technical authorities, but as institutional facilitators who connect informal learning with recognition and support.

Peer Learning: Opportunity and Instability

Peer learning emerged as one of the most influential mechanisms shaping students' engagement with jazz. Student-led bands and rehearsals functioned as informal communities of practice, where musical knowledge, norms, and identities were negotiated socially. Peer influence often motivated students to try jazz for the first time, even when it was not their preferred genre, demonstrating the powerful role of social belonging in musical decision-making.

At the same time, the absence of formal structures—such as clear leadership, assessment criteria, or long-term goals—made peer learning fragile. Groups frequently dissolved due to conflict, uneven skill levels, or competition for status. Without assessment or institutional constraints, practice was sometimes inefficient, exclusionary, or unstable. These findings complicate celebratory accounts of peer learning by showing that informality without support can undermine continuity and equity. Gender dynamics further intensified these challenges, as female students reported difficulty entering and remaining in male-dominated jazz groups, an issue that informal structures alone struggled to address.

Assessment and Recognition

Assessment emerged as a critical site of tension. Students expressed pride and motivation when performing for audiences, and public performance functioned as a powerful form of recognition. However, the exclusion of jazz performances and ensemble work from formal grading systems led to frustration and devaluation. Students questioned the legitimacy of their jazz learning when it carried no academic weight, despite significant time and effort invested.

Green (2017) argued that informal learning resists traditional assessment frameworks and that over-assessment risks undermining intrinsic motivation. This study both supports and challenges that claim. While students valued the freedom of informal learning, they also desired assessment that acknowledged their work, particularly in the educational context which is necessary for university application. Alternative assessments—such as performance-based evaluation, portfolio assessment, digital badges, and peer assessment—may offer ways to recognize informal learning without imposing rigid formalism. The findings suggest that equitable music education requires not less assessment, but more appropriate forms of assessment that validate diverse learning pathways.

Identity Exploration Without Consolidation

Identity emerged as the most consequential theme. Most students occupied a Moratorium status, actively exploring jazz but unable to commit due to uncertainty about future pathways, lack of institutional recognition, and parental resistance. Even when jazz functioned as a meaningful hobby, it rarely supported identity consolidation. Informal learning enabled exploration but did not provide sufficient stability for long-term commitment.

Parental expectations and gender norms further constrained identity development. Jazz was often viewed by parents as economically risky or culturally less legitimate than classical music, limiting emotional and financial support. Female students faced additional barriers in peer communities and internalized doubts about belonging. Only a small number of students achieved identity consolidation, typically those with access to supportive families.

Conclusions

This study examines the integration of informal and formal jazz learning in a secondary school context in Shanghai, highlighting both opportunities and challenges. Informal learning strategies, such as peer collaboration and digital platforms, were key to fostering student engagement and identity exploration. However, the lack of formal instruction in areas like music theory hindered students' ability to fully apply their informal learning. While teachers played a vital mediating role, their limited expertise in jazz and the absence of dedicated jazz curricula left gaps in students' education. Peer learning was crucial but often unstable, and the lack of formal recognition of jazz learning within the school system created frustration. Gender dynamics also emerged as a barrier, with female students facing additional challenges in predominantly male jazz groups and experiencing greater difficulty in developing a sense of belonging. Furthermore, family expectations were a significant factor in shaping students' musical identities. Many students reported that their parents prioritized more traditional and financially stable career paths, such as classical music or business, over jazz, which was often perceived as a less viable career option. This pressure created conflicts between pursuing personal passions for jazz and meeting parental expectations, leading to uncertainty in their identity development. The findings suggest that a more balanced approach combining informal learning with formal theory instruction, gender-inclusive support, family engagement, and appropriate recognition is necessary for equitable and sustainable jazz education in secondary schools.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that Grammarly, an AI-assisted writing software, was used in proofreading and refining the language used in the manuscript. The usage was limited to

correcting grammatical and spelling errors and rephrasing statements for accuracy and clarity. The author further declares that, apart from Grammarly, no other AI or AI-assisted technologies have been used to generate content in writing the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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Contact email: 24484407@life.hkbu.edu.hk

A Comparative Study of Procedural and Strategic Scaffolding in Interactive Video-Based Learning for Financial Literacy

Ching Fang Hu, National University of Tainan, Taiwan
Hao Chiang Koong Lin, National University of Tainan, Taiwan

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Abstract

As the financial landscape becomes increasingly complex, equipping university students with financial literacy and practical application skills has become a critical focus in contemporary education. Traditional instruction tends to emphasize knowledge transmission, offering limited support for students' practical decision-making and strategic thinking. In response, this study adopted interactive video-based instruction, integrating two types of learning support strategies—procedural scaffolding and strategic scaffolding—to explore their potential impact on students' learning outcomes and processes. Using a quasi-experimental design, students without a finance-related academic background were randomly assigned to two groups. Multiple assessment tools, including a financial literacy scale, concept mapping, and performance-based tasks, were employed to examine knowledge construction and strategic application. The findings aim to inform future instructional design and personalized learning support strategies in digital financial education.

Keywords: financial literacy, interactive video, procedural scaffolding, strategic scaffolding, digital learning

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Introduction

With the increasing diversity of financial products, financial literacy has become a key competency for modern citizens (Lusardi et al., 2017). Although students generally possessed basic financial knowledge, they often struggled with practical application and decision-making, revealing the limitations of traditional instruction that emphasized content transmission over applied skills (Yin Yin et al., 2023; Zaini et al., 2022). Effective learning should have incorporated strategic guidance and procedural support to foster higher-order thinking (Belland et al., 2013; Shao et al., 2023).

Scaffolding strategies, as an effective form of instructional support, provide phased assistance tailored to learners' needs, thereby enhancing task performance and cognitive engagement. This study focuses on the differential effects of procedural and strategic scaffolding on students' learning processes and decision-making behaviors. By integrating these scaffolding approaches into interactive video-based instruction, two types of scaffolded learning videos were developed to support students' acquisition of financial literacy. The goal is to clarify how different scaffolding designs contribute to learning outcomes and to address the current gap in empirical research.

Accordingly, this study aims to examine whether procedural and strategic scaffolding designs result in different levels of financial knowledge acquisition and application among university students in a financial literacy course. It also investigates whether students' decision-making behaviors vary depending on the type of scaffolding embedded in the interactive videos. Ultimately, the study seeks to propose a theoretically grounded and practically applicable model for digital instructional design in financial education.

Literature Review

Application of Procedural and Strategic Scaffolding

The concept of scaffolding, first introduced by (Wood et al., 1976), emphasized the provision of temporary support by instructors to help learners accomplish tasks they were not yet able to complete independently. Core functions of scaffolding included task guidance, reducing complexity, managing frustration, highlighting key information, and modeling task execution. Hannafin et al. (2013) further classified scaffolding into four types—conceptual, procedural, strategic, and metacognitive—and stressed the importance of dynamically adjusting support throughout the learning process while incorporating context and reflection to foster learner autonomy.

Procedural scaffolding focused on the “how-to” of learning by offering learners clear task explanations and operational steps. It helped students build task-execution skills through sequenced and structured guidance (Chen et al., 2011; Huang et al., 2012). Typical applications included task initiation, step-by-step breakdown, decision cues, real-time feedback, and knowledge transfer to new contexts. Research showed that procedural scaffolding reduced cognitive load and enhanced skill development when it was widely implemented in digital learning, multimedia instruction, and hands-on courses (Kaldaras et al., 2024; Thomann & Deutscher, 2025). When combined with digital prompts and technologically enabled feedback, it could also enhance learners' reflection and adjustment capabilities (Nonthamand, 2024).

In contrast, strategic scaffolding emphasized “how to think” or “how to choose,” using questioning and reflective prompts to guide learners in complex tasks (Belland et al., 2013; Hannafin et al., 2013). This type of scaffolding has been widely applied in science education, language learning, and game-based learning environments. Studies confirmed that strategic scaffolding enhanced reasoning, creative thinking, and self-monitoring (Alanazi et al., 2024; Wang et al., 2025). Similarly, Sun et al. (2023) found that phased questioning and adaptive support significantly enhanced students’ self-regulated learning and problem-solving abilities by facilitating planning, monitoring, and reflection processes. Research further demonstrated that it contributed to the improvement of learners’ self-regulation strategies and academic performance (Li et al., 2023; Shao et al., 2023).

In sum, while procedural and strategic scaffolding addressed different dimensions, both were valuable for supporting cognitive development. Procedural scaffolding enhanced operational capability and simplified complex tasks, whereas strategic scaffolding promoted effective strategy use and self-regulation (Faber et al., 2024; Zuo et al., 2023). Building on this distinction, the present study adopted these two types of scaffolding as instructional variables to examine their specific applications and effected in the context of digital financial literacy learning.

Instructional Applications of Multimedia Tools

Video has become one of the most widely used media in multimedia instruction due to its dual-channel advantage of visual and auditory input, which enhances the concretization of abstract concepts and increases learners' motivation (Pan et al., 2012; Zaini et al., 2022). According to multimedia learning theory, instructional videos that were designed in alignment with multimedia principles were more effective in facilitating knowledge construction and procedural learning (Mayer & Moreno, 2003; Zhang et al., 2006).

However, traditional videos are inherently passive and lack opportunities for feedback and interaction. Interactive videos, by contrast, incorporated embedded questions, branching scenarios, and real-time feedback mechanisms to engage learners in ongoing judgment, reflection and strategy adjustment during the viewing process. This interactivity enhanced learners’ sense of engagement and promoted better learning outcomes (Dahlan et al., 2023; Haerawan et al., 2024; Kim et al., 2015; Vakilian et al., 2022). Instructors could also utilize learning analytics tools to track student progress and provide differentiated and personalized guidance (Staneviciene & Žekienė, 2025).

In financial education, interactive videos showed strong potential. Research indicated that such tools not only improved learners’ financial knowledge and behavioral performance (Lusardi et al., 2017; Zaini et al., 2022), but also fostered active learning and self-regulation (Azevedo et al., 2010; Moreno & Mayer, 2007). When combined with scaffolding, interactive videos served as effective vehicles for a dual-cycle learning process of “view–reflect–respond” and “question–reflect–apply.”

Procedural scaffolding could be embedded into videos through nodes such as task initiation, step-by-step guidance, decision prompts, feedback correction, and transfer challenges, enabling learners to clearly grasp the operational process and task structure (Gündüzalp, 2024; Nonthamand, 2024; Pan et al., 2012). On the other hand, strategic scaffolding might be incorporated via strategic cues, reflective tasks, and open-ended scenarios to enhance

learners' depth of thinking and self-monitoring skills (Alanazi et al., 2024; Li et al., 2023; Wang et al., 2025; Zheng, 2016).

In summary, the integration of scaffolding design supported the acquisition of procedural knowledge but also facilitated the development of strategic thinking and higher-order learning (Shao et al., 2023; Sun et al., 2023). Based on this rationale, the present study developed two versions of scaffolding-based interactive videos and examined their differential effects on students' financial literacy learning, aiming to offer concrete implications for multimedia instructional practices.

Methodology

This study aims to explore the effects of integrating procedural scaffolding and strategic scaffolding with interactive video instruction on the financial literacy learning outcomes of university students. To achieve this goal, this chapter outlines the instructional design rationale, the video production process, and the application of scaffolding strategies. By clarifying how different scaffolding interventions affect learning outcomes in multimedia learning environments, the findings are expected to provide practical insights for the development of future digital instructional models and course design.

Learning Content Design

The learning content design for university students focuses on four major themes, beginning with understanding types of expenses by distinguishing between “needs” and “wants” as well as fixed versus variable expenses to establish fundamental budgeting and management concepts. To help students reach various financial goals, the sources detail the differences in savings instruments, comparing regular savings, fixed deposits, and high-yield accounts based on their interest rates, liquidity, and risk. The curriculum also guides students in selecting investment instruments, such as stocks, ETFs, and mutual funds, while emphasizing risk-return evaluation and the development of an understanding regarding personal risk tolerance. Finally, students are taught principles of financial allocation through frameworks like the 6-3-1, 3-3-3, and 50/30/20 rules, which encourage effective income and expense planning and the rational allocation of resources in their daily lives.

Video and Scaffolding Design

This study developed two types of interactive multimedia instructional videos, each incorporating either procedural scaffolding or strategic scaffolding, to examine the effects of different scaffolding strategies on college students' learning processes and decision-making performance in financial literacy. The videos were designed based on multimedia learning principles (Mayer & Moreno, 2003), utilizing dual channels of animation and narration to convey financial concepts. Interactive tasks and contextual decision points were embedded at key moments to enhance learner engagement, cognitive processing, and strategy application.

The video for the procedural scaffolding group focused on task-oriented guidance through five stages. As shown in Table 1, these stages included: Task Orientation, utilizing context-based scenarios to establish clear learning goals and focusing student attention on the specific content. This was followed by Step Decomposition, which segmented complex tasks into manageable parts and used interactive modules to help students master operational procedures. The third stage, Decision Prompts, employed multiple-choice questions

accompanied by strategic hints to guide students through initial decision-making processes. To ensure understanding is reinforced, the Feedback and Revision stage provided immediate, personalized responses that facilitate error correction. Finally, the process culminated in Internalization and Transfer, where students were presented with novel contexts to encourage the flexible application of learned strategies to new challenges. This structure was designed to reduce cognitive load and strengthen procedural execution (Chen et al., 2011; Huang et al., 2012).

In contrast, the strategic scaffolding group focused on higher-order thinking and self-regulation, consisting of three core stages. As shown in Table 1 and Table 2, the educational framework detailed in the sources focuses on three core stages to enhance strategic financial decision-making: Strategy Activation, Reflection and Adjustment, and Internalization and Transfer. During the Strategy Activation phase, students were introduced to diverse financial thinking paths—such as risk-based, goal-oriented, and time-oriented approaches—to help them engage more effectively in strategic planning and decision-making. This was followed by Reflection and Adjustment, which utilized metacognitive questioning to prompt students to evaluate different options and outcomes, thereby supporting a deeper reflection on their reasoning and strategy adjustments. Finally, the process of Internalization and Transfer involved the gradual fading of external support, placing students in open-ended decision-making scenarios to encourage the independent application of strategies and the integration of these concepts into their personal thinking models (Alanazi et al., 2024; Belland et al., 2013; Zheng, 2016).

Both videos followed a “Task–Interaction–Feedback” design loop but differed in their scaffolding emphasis: procedural scaffolding aimed at clarifying operational processes and building task skills, while strategic scaffolding focused on developing flexible thinking and transferable strategies. Leveraging interactive video as the instructional medium, this study examined how each scaffolding approach supported learners in constructing knowledge and navigating financial decisions. The instructional design served as the foundation for analyzing the differential impact of scaffolding strategies on learning outcomes, offering both theoretical insight and practical guidance for future digital financial education.

Table 1
Interactive Video and Procedural Scaffolding Design

Procedural Scaffolding	
Task-oriented guidance	Introduce a financial scenario based on a monthly income of NT\$30,000 and set a financial task (e.g., creating a budget or savings plan).
Step-by-step breakdown	Teach the 50/30/20 budgeting method and basic bookkeeping practices.
Decision cues	Present a decision situation in which NT\$5,000 remains at the end of the month.
Feedback and correction	Display different financial outcomes based on the learner’s choices (e.g., successful saving vs. overspending).

Table 2
Interactive Video and Strategic Scaffolding Design

	Strategic Scaffolding
Strategy guidance	Present the same scenario: “How should a monthly income of NT\$30,000 be managed?”
Reflective adjustment	Introduce three budgeting strategies (aggressive, stable, conservative).
Strategy guidance	Present the same decision situation (“You have NT\$5,000 left at the end of the month”) for allocation decisions.
Reflective adjustment	Display the decision outcomes and illustrate the reasoning pathway, followed by reflective questions.

Experimental Design and Procedure

This study adopted a quasi-experimental design to examine the effects of procedural and strategic scaffolding integrated with interactive video on college students’ financial literacy learning outcomes. A total of 80 undergraduate students from non-finance and non-accounting majors were randomly assigned to two groups: the procedural scaffolding group (control group, $n = 40$) and the strategic scaffolding group (experimental group, $n = 40$). Both groups received the same instructional content and duration, with the only difference being the scaffolding strategy, ensuring consistency in the instructional intervention and enabling clear evaluation of the scaffolding type’s effect on learning outcomes.

The experiment was conducted in three distinct stages to evaluate the effectiveness of the instructional intervention. In the pre-test stage, researchers measured students’ prior knowledge and conceptual structures using a financial literacy assessment and a concept mapping task. During the subsequent instructional intervention, students engaged with interactive videos featuring tasks and strategy prompts that aligned with their specific scaffolding conditions. The process concluded with a post-test stage, which involved re-administering the initial assessments alongside a context-based performance assessment and a learning feedback questionnaire to comprehensively analyze students’ decision-making, strategy application, and reflections.

To comprehensively evaluate the impact of scaffolding design on learning processes and outcomes, four specialized instruments were employed. The Financial Literacy Scale, which was validated through expert review to ensure content validity and item discrimination, utilized a 5-point Likert scale to measure cognitive gains in areas such as fundamental financial concepts, saving and investment decisions, risk awareness, and resource allocation strategies. To examine internal cognitive organization, the Concept Mapping Task analyzed nodes, hierarchies, and logical links to provide insights into changes in students’ knowledge structures, depth of understanding, and strategic thinking processes. Complementing this, the Context-Based Performance Assessment presented students with realistic financial decision-making tasks, using a rubric focused on reasoning quality, strategy use, and the justification of decisions to capture applied learning behaviors in everyday contexts. Finally, the Learning Feedback Questionnaire gathered subjective perceptions through closed-ended items regarding learning engagement, video acceptance, and the frequency of strategy usage, while open-ended questions explored students’ reflective thoughts and personal experiences with the provided scaffolding support.

In sum, the four instruments triangulated data across cognitive, structural, behavioral, and affective dimensions, enabling a comprehensive assessment of learning outcomes. This approach not only evaluated the instructional effectiveness of each scaffolding strategy but also provided deeper insights into their practical applications and impact within digital financial learning environments (Belland et al., 2013; Shao et al., 2023).

Expected Results

This study aims to identify differences in students' learning processes and decision-making behaviors following the integration of two distinct types of scaffolding—procedural scaffolding and strategic scaffolding—into interactive video-based instruction. Given the consistent instructional content and learning time across groups, the type of scaffolding support will serve as the primary variable influencing students' learning performance. A variety of data collection tools, including pre- and post-tests, performance-based assessments, interaction process analysis, and learning feedback questionnaires, will be employed to comprehensively capture changes in students' knowledge acquisition, strategy use, and learning experiences.

At the knowledge level, students' performance before and after the intervention will be compared using a financial literacy scale and concept mapping tasks. These measures are expected to provide insights into whether the combination of interactive video and scaffolding design contributes to varying degrees of conceptual understanding and knowledge construction. Through the analysis of concept maps, we can observe how students' structure financial concepts and track the progression of their underlying cognitive schemas.

In terms of learning processes, the study will also examine students' behavioral patterns and decision-making strategies as they interact with the videos. Procedural scaffolding is expected to result in a more linear and stable learning trajectory due to clear operational cues. Conversely, strategic scaffolding may lead to more diverse and nonlinear learning paths by encouraging information evaluation and reflective thinking. Subjective data from questionnaires will clarify students' receptiveness to these designs and their impact on motivation. Whether the different scaffolding strategies affect students' sense of engagement, learning motivation, or perceived strategy use is one of the key aspects this study seeks to examine. This study expects to map the varying influences of scaffolding designs on learner performance, offering an unbiased analysis of the diverse cognitive pathways and performance patterns they elicit. The results will likely yield evidence-based insights necessary for the development of adaptive instructional designs, specifically informing how personalized support can be integrated into digital financial literacy programs.

Conclusion

This study investigates the impact of integrating different scaffolding designs with interactive videos on financial literacy, learning processes and decision-making behaviors. Through a quasi-experimental design and the use of multiple assessment tools, the research intends to objectively examine how different scaffolding strategies may influence various aspects of learning, including knowledge construction, task execution, strategy application, and learning engagement.

Preliminary frameworks suggest that procedural scaffolding supports task efficiency and reduces cognitive load, while strategic scaffolding facilitates reflective judgment in open-ended contexts. These findings will provide an empirical basis for future instructional design in digital financial education. During the instructional process, the use of interactive video as a medium is expected to further enhance student engagement and the feedback loop, potentially interacting with the type of scaffolding employed and influencing students' learning trajectories and performance patterns.

Overall, although the experiment has not yet been conducted, the study—grounded in a clear instructional framework and theoretical rationale—lays a foundation for analyzing the possible roles and effects of different scaffolding strategies in digital financial learning environments. The insights gained may serve as a theoretical and practical basis for future empirical research and instructional development in learner-centered financial education.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that an AI-assisted writing tool was used in proofreading and refining the language of this manuscript. The usage was limited to correcting grammatical errors, ensuring consistency between Chinese and English sources, and rephrasing statements for academic clarity according to the IAFOR guidelines. The author further declares that no AI or AI-assisted technologies have been used to generate content in writing the manuscript. The idea, design, procedure, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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Contact email: ssd77013@gmail.com

Student Attitudes and Perceptions of AI and AI-Generated Practice in the Classroom

Rachel Van Campenhout, VitalSource, United States
Michelle Clark, VitalSource, United States

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Abstract

Despite the prevalence of AI tools, research is still emerging on how students perceive them and use them in their studies. Faculty teaching three courses at Iowa State University used AI-generated practice alongside the etextbook as a low-stakes homework assignment. While prior research on this practice has found it effective for learning, it was important to better understand how students perceive and use AI generally, in addition to this specific tool. In this investigation, 234 students across three courses responded to end-of-semester survey to capture their course perceptions, general comfort and trust levels with AI, frequency of use, types of use, and perceptions of the AI-generated questions more specifically. Survey findings suggest that student usage and attitudes toward AI remains varied. While a small portion of learners appear comfortable integrating AI tools into their studies, many remain infrequent users of such technology, with the most frequent use for AI being spelling and grammar support. It is key for those in higher education and educational technology alike to keep in mind that the ease of access and pervasiveness of AI tools does not equate to ubiquitous student use, mastery, or sophisticated learning strategies. In light of these survey findings, the need for effective AI tools for classroom implementation as well as general AI literacy strategies for teaching and learning are discussed.

Keywords: formative practice, artificial intelligence, automatic question generation, student perception

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Introduction

A substantial body of prior research has demonstrated that formative practice improves learning outcomes across disciplines, with particularly strong benefits for students who are struggling (Black & Wiliam, 2010). As it functions as no- or low-stakes practice testing, formative practice is one of the most effective and well-supported study strategies (Dunlosky et al., 2013). Formative practice is defined here as questions that support students in monitoring their comprehension and learning. These questions are generally ungraded or low stakes, provide immediate feedback, and allow students to attempt them repeatedly without penalty.

The connection between formative practice and learning is further clarified through research on the doer effect conducted by Carnegie Mellon University's Open Learning Initiative (OLI). Advances in digital learning environments have enabled the collection of large-scale, fine-grained learning data (Goldstein & Katz, 2005), allowing longstanding educational questions to be revisited using new analytical approaches (Fischer et al., 2020). In these environments, every learner interaction is captured as clickstream data, making it possible to disentangle the effects of reading and doing. Using OLI courseware data that included reading, doing, and video watching behaviors, Koedinger et al. (2015, 2016) found that engaging in practice was approximately six times more effective for learning than reading alone. Subsequent analyses established that this doer effect reflects a causal relationship between doing and learning (Koedinger et al., 2016; Koedinger et al., 2018). Follow-up replication studies reproduced both the correlational and causal findings, supporting the robustness and generalizability of this effect across contexts (Van Campenhout et al., 2021a; Van Campenhout et al., 2022; Van Campenhout et al., 2023b).

In recent years, automatic question generation (AQG) systems have emerged that employ diverse techniques and serve a wide range of instructional goals (Kurdi et al., 2020). However, much of the existing research on automatically generated (AG) questions has not incorporated student interaction data, and Kurdi et al.'s systematic review found no established gold standard for evaluating question quality or performance (2020). To extend the benefits of the doer effect to a broader population of learners, an artificial intelligence-based AQG system was developed to generate formative practice directly from textbook content. The AG questions referred to in this work have been empirically validated using student data collected in authentic learning settings, contributing to the development of performance benchmarks for AG formative practice. Prior large-scale studies have compared AG questions with human-authored items on measures including engagement, difficulty, persistence (Van Campenhout et al., 2023a), and discrimination (Johnson et al., 2022); established stable performance benchmarks using over 24 million student-question interactions (Van Campenhout et al., 2021b; Van Campenhout et al., 2025a); analyzed student interaction behaviors (Van Campenhout et al., 2023c) and the effectiveness of AG feedback (Van Campenhout et al., 2024b); and examined classroom implementations of these questions (Van Campenhout et al., 2024a). Most significantly, research on these AG questions were able to replicate the doer effect research, proving for the first time that AI-generated questions could similarly generate the doer effect for students (Van Campenhout et al., 2025c).

Figure 1

An Example of a Formative Practice Question in a Textbook

Prospective-memory tasks have been studied by researchers in two ways: as they occur in everyday life (e.g., remembering to call someone at a specific time) and as they occur in laboratory tasks (e.g., remembering to press a key when one sees a specific word in a task). In both cases, the prospective-memory tasks are designed to simulate typical prospective-memory tasks that people perform in their everyday lives (e.g., remembering to call your mother on her birthday). To allow more control over the factors that can influence prospective-memory performance, Einstein and McDaniel (1990) developed a frequently used laboratory procedure to study prospective-memory tasks. In this lab-based method, a prospective-memory task is embedded within an ongoing task to simulate the remembering of a prospective-memory task within the typical tasks of everyday life. The prospective-memory tasks given in studies employing Einstein and McDaniel's methodology typically involve asking subjects to make a certain response (e.g., press the 5 key) when they encounter a specific word (e.g., *rabbit*) or specific type of word (e.g., animals). The subjects are then asked to perform an ongoing task (e.g., rate the pleasantness of words or decide if a string of letters is a word) while they attempt to remember the prospective-memory task. Using this methodology, researchers are exploring questions about how prospective memory works, such as: How much attention is needed to perform the prospective-memory task (e.g., Einstein et al., 2005)? Does prospective-memory performance decline with age (e.g., Kvavilashvili, Kornbrot, Mash, Cockburn, & Milne, 2009)? What are the effects of delay on prospective-memory performance (e.g., McBride, Beckner, & Abney, 2011)?

Why We Forget

Why do we forget things? Why aren't we able to retrieve important information when we need it? The process of forgetting has been studied for as long as there has been a field of experimental psychology. Forgetting is a natural process that occurs when information is unable to be retrieved from memory. The inability to retrieve information generally seems to increase as the time since the information was learned increases. Ebbinghaus (1885) first showed that forgetting follows a typical pattern where a lot of information is forgotten very quickly after study, but then the rate of loss slows as the length of time since study increases. Figure 6.2 illustrates this classic pattern. This pattern of forgetting has held up over many studies in the time since Ebbinghaus's experiments.

CoachMe[®] Question Progress x

Practice Questions

< 1 2 3 4 >

instruction recall recognition

Implicit-memory tasks typically involve a cue, as in the cued - Select - tasks described earlier, or identification, as in the - Select - tasks described earlier, but no - Select - to retrieve a memory is given as it is in explicit-memory tasks.

Check Answer

However, student perceptions and attitudes can influence the success of these questions through engagement. One study on formative practice found students can undervalue practice as a learning tool (Carvalho et al., 2017). The addition of AI learning tools only adds layers of complication surrounding perception and use. Despite its prevalence, Kelly et al. (2023) point out that research specifically examining student perceptions of AI in learning contexts is still emerging. Some studies surveying students' perceptions of AI discovered relatively low usage and experience with the technology, lack of understanding of the tools' strengths and weaknesses, and low confidence in their application for learning (Chan & Hu, 2023; Smolansky et al., 2023). Another study of higher education students from the same time period found 70% of students and faculty used generative AI tools less than once a week (Kim et al., 2025). Qualitative research using student focus groups found that students perceived the most beneficial aspects of AI to include academic support and increased efficiency, however, major concerns and anxieties remained surrounding academic integrity, inequity, decreased ability to learn and be creative, and unclear university policies (Tierney et al., 2025). Not only is it important to learn how students view formative practice in general, the cultural focus on AI also makes it necessary to gain a sense of how students view AI-generated questions. While the development work to create effective learning tools is significant and the validation of the tool using data is critical for early interpretation of its success, student perception is equally important to understand and address.

In this paper, student perceptions of AI-generated formative practice were gathered from three courses at a major higher education institution in the fall of 2024. While the faculty had two years of experience teaching with these AI questions as part of their courses, the broader explosion of generative AI raised new questions on what students were thinking and doing. This motivated researchers to ask the following questions:

1. How do students perceive AI generally?
2. How do students use AI in their studies?
3. How do students perceive formative practice once they know it was AI?

Methods

Faculty had previously taught several semesters using the AI generated practice, establishing successful implementation practices (Van Campenhout et al., 2024a). Faculty assigned textbook chapters and the corresponding practice questions on a weekly basis, with a small percent of students' grade determined by completing a minimum of 80% of the practice. Note that this score is completion—not accuracy—based to maintain the nature of low-stakes formative practice.

At the end of the semester, faculty provided students with a link to a survey aimed at gathering feedback and descriptive information on student perceptions of the questions. To encourage honesty, the survey was completely anonymous. Because the survey sought informal feedback rather than measuring a specific psychological construct, no formal psychometric validation was undertaken. This approach is consistent with prior end-of-semester feedback practices, which aim to gauge overall impressions rather than provide a high-stakes assessment.

Results and Discussion

The survey participation rates were 27% (13 of 47 students) for CJ, 76% (157 of 205 students) for COM, and 100% (64 of 64 students) for FAM. The initial portion of the anonymous survey was to gather preliminary information from students to provide context for their later responses. This included asking about their perceived difficulty of the course, expected grade, and digital versus print book preferences. This is useful context setting to better understand how students feel about their course and materials. For example, there is typically a small portion of students who strongly prefer print to digital books, and this same portion of students typically report less favorable attitudes toward the practice questions (Van Campenhout et al., 2025b). This was the case for these courses, where 15.4%, 2.9%, and 1.4% of students preferred digital much less than print, contrary to the majority of their peers. Tables 1 and 2 show results related to students' general perception of all CoachMe questions as formative practice. When asked if they thought that generally doing practice while reading is helpful for learning, the majority of students said yes, with a smaller group unsure, and a few students saying no. Note that the 15.4% who said no for CJ was the same portion who disliked digital books compared to print. Students were then asked if they found the CoachMe practice questions helpful for learning. This is an important distinction from a general attitude toward the learning method, as students could find a method beneficial but not necessarily this specific application. Table 2 shows the majority of students found it very or moderately helpful, with again, only a small portion finding them not helpful. These results are consistent with those from previous semesters of these same courses (Van Campenhout et al., 2025b).

Table 1

Student Perceptions of Practice Questions as a Learning Tool

In general, do you think doing practice questions while reading is helpful for learning?	Yes	Maybe	No
CJ	61.5	23.1	15.4
FAM	79.4	16.2	4.4
COM	73.2	22.9	3.9

Table 2*Helpfulness Ratings of Practice Questions for Studying and Assignments*

How helpful did you find the practice questions for studying and preparing for assignments?	Very Helpful	Moderately Helpful	Somewhat Helpful	Not at all Helpful
CJ	38.5	30.8	30.8	
FAM	36.8	45.6	13.2	4.4
COM	34.0	37.8	23.7	4.5

Students were also asked about their comfort level with AI and how they utilize AI in their life. Table 3 shows students' comfort/trust level for each of the three courses. The results show a roughly normal distribution with few students selecting not at all or extremely comfortable, and the majority of students in the course selecting the mid comfort level. Table 4 shows the responses for how often students use generative AI tools. Similarly, few students selected often or never, and most selected sometimes or seldom.

Table 3*Student Comfort and Trust Levels With AI*

How would you rate your comfort/trust level with AI?	1 Not at all comfortable	2	3	4	5 Extremely Comfortable
CJ	7.7	7.7	69.2	7.7	7.7
FAM	-	26.5	41.2	27.9	4.4
COM	5.1	10.9	37.8	32.1	14.1

Table 4*Frequency of Generative AI Usage by Students*

How often do you use generative AI tools (such as ChatGPT)?	Often	Sometimes	Seldom	Never
CJ	-	23.1	61.5	15.4
FAM	7.4	36.8	35.3	20.6
COM	11.5	50.3	28.0	10.2

Students were also given an open-ended question where they were asked to describe how they used generative AI, with a reminder that their responses were anonymous. Besides some students noting they do not use generative AI at all, the most common use students cited was for help with grammar, spelling, and formatting for their writing. Several students stated that they use it to get new ideas and brainstorm for assignments. A few students cited more sophisticated learning uses such as generating practice questions or getting new explanations for concepts they didn't understand.

Students were then informed that the practice questions were generated using AI and asked if they knew that prior to using them. Despite faculty's knowledge and a note accompanying question feedback that was generated with AI, nearly all students did not realize they were AI-generated (100%, 91.2%, and 82.5% for each course respectively). Students were then asked if knowing they were AI-generated changed their perception of the questions. The results in Table 5 show the majority of students felt they were just as useful as before (69.2%, 73.5%, and 71.3% of students in each course respectively). A small portion of students felt they were more beneficial after learning they were AI-generated, while a larger portion of students felt

they were less beneficial. This information adds a layer of complexity to student perception of AI when considered with to their initial thoughts on the questions.

Table 5

Effect of AI Origin on Perceived Usefulness of Practice Questions

Does knowing they were created using AI (rather than by professors, for example) make you feel differently about their usefulness?	I feel the same way	I feel they are more beneficial knowing they are made with AI	I feel they are less beneficial knowing they are made with AI
CJ	69.2	7.7	23.1
FAM	73.5	13.2	13.2
COM	71.3	8.3	20.4

As new learning tools based on AI technology are developed, continuing to monitor student perception of those features is key to determining satisfaction. In the survey answered by students across all three courses, students responded similarly to prior semesters (Van Campenhout et al., 2025b); students generally thought doing practice while reading was beneficial for learning, and a similar proportion of students thought these AI-generated questions were helpful for learning. When asked generally about their comfort level/trust of AI tools, the responses formed a roughly bell-shaped distribution, with fewer students at either extreme of comfort. When asked how often they used AI tools, most students selected seldom or sometimes. For students who do use AI, the most common use reported was for grammar, spelling, and formatting support. Only a small portion of students stated that they used AI for learning tasks such as generating more practice or explaining concepts that were confusing. These survey responses serve as a valuable reminder that despite the current widespread enthusiasm surrounding generative AI, not all students have expertise in, or even regularly make use of, these tools. It could be easy for faculty, administrators, and technology developers to amalgamate the sudden popularity of generative AI with ubiquitous use and expertise by students. But this is not yet the case. These typical university students are still novices in their own use of AI and evolving in their comfort, trust, and perceptions of these emerging AI tools.

The survey responses also revealed noteworthy insights regarding student awareness of AI involvement in question generation and feedback. Despite faculty being aware of this and a notice on AI-generated feedback in the user interface, nearly all students reported being unaware that the questions were AI-generated. Most students, once realizing questions were created with AI, felt they were as beneficial as before. A few students felt they were more beneficial, but a small proportion felt they were less beneficial than before. What's notable is there is a similar percentage of students who only found the questions only somewhat helpful in the first place; it could be that this same group who only found them somewhat helpful considered them even less so once discovering their AI origins. These responses raise issues of AI transparency and trust. In this case, the AI-generated questions have shown to be beneficial, and students found them to be helpful prior to knowing their generation status. Does ensuring students know the AI origination of the questions increase overall trust, or could that inadvertently erode the benefit of the questions by diminishing the perception of them for some students? Could some type of education on the generation method and validation research change student perception? These are avenues for further consideration and research.

Conclusion

Survey findings suggest that student usage and attitudes toward AI remains varied. While a small portion of learners appear comfortable integrating AI tools into their studies, many remain infrequent users of such technology, with the most frequent use for AI being spelling and grammar support. These findings on overall usage are consistent with those from Kim et al.'s (2025) survey of 982 university students, where 70% of students used AI tools once a week or less. It is key for those in higher education and educational technology alike to keep in mind that the open access and explosion of AI tools does not equate to ubiquitous student use or, importantly, mastery.

Notably, most students did not realize these new questions or their feedback were AI-driven. The majority of respondents indicated that learning-by-doing activities are beneficial for studying and that their perception of the questions was unchanged when they discovered they were developed with AI. However, discovering the AI origin influenced perceptions for a small portion of students, raising questions about transparency and trust. Regarding the AI questions assigned to these students, the learning science basis and efficacy research prove their effectiveness for learning, so a negative perception of AI reducing trust and use is not a desired outcome. Therefore, we recommend transparency with students not only that the questions were generated with AI, but also the learning science and efficacy research that explains both the rigor of the AI questions and their benefit for learning.

Based on these student perception findings further contextualized by similar research recently conducted, there are several recommendations for faculty to guide teaching and learning practices with AI tools. First, try to understand how often students are using AI and what they are using it for. Research has shown usage may not be as frequent as thought and most students are not using sophisticated learning strategies, but this may change over time. Knowing this information—even informally—can help shape both expectations and assignments. Second, ensure expectations for AI use for course assignments are both clear and aligned with university policies to provide maximum clarity for students. This includes AI tools used in the course and their purpose for learning, as previously mentioned. Third, as concluded in Tierney et al. (2025), students were most positive regarding AI tools that provided academic support, which aligns closely with our final recommendation that AI tools selected for classroom use be based in the learning sciences and have effectiveness research to confirm their benefits for students in natural learning contexts. In continuing to monitor student perceptions, researchers and developers can ensure that emergent generative AI capabilities support rather than alienate learners.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The authors declare that no AI or AI-assisted technologies were used to generate or refine the content of this manuscript. This is original research conducted entirely by the authors.

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Contact email: rachel.vancampenhout@vitalsource.com

Negotiating Obligation: Investment, Positioning, and Identity in Duty-Based Korean Language Learning

SooJin Jung, Defense Language Institute Foreign Language Center, United States

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Abstract

This study examines how duty-based adult learners of Korean construct and negotiate learner identities in an institutional setting where language study is mandated as part of professional roles. Drawing on Positioning Theory, Gee's discourse/Discourse distinction, and Norton's investment framework (Davies & Harré, 1990; Gee, 2011; Norton, 2013), the study analyzes multiweek reflective writings from adult learners in a Korean language program linked to occupational assignments. Using discourse-analytic coding, the analysis focuses on four domains: identity positions (self-as-competent or self-as-struggling, role conflict), investment and motivation (instrumental, integrative, resistant, reframed orientations), Discourses and ideologies (institutional performance discourses, cultural essentialism, critical awareness), and emotional and affective stances (confidence, anxiety, ambivalence, empowerment). Findings reveal persistent tensions between institutional expectations and personal agency, with investment fluctuating according to perceived relevance, modality, and opportunities for learner choice. Learners articulate diverse forms of agency—strategic use of Korean media, preference for kinesthetic and competitive activities, meticulous self-regulation, and deliberate participation—which reframe obligation as meaningful practice. Simultaneously, deficit positioning and performance pressures emerge in narratives of perfectionism, introversion, neurodiversity, and time-constrained proficiency targets, illustrating how institutional Discourses shape participation and self-understanding. The study contributes theoretically by integrating positioning, Discourse, and investment to explain identity work under institutional constraint, and pedagogically by outlining equity-oriented, multimodal, and asset-based strategies for designing more inclusive duty-based language programs.

Keywords: duty-based language learning, learner identity and positioning, learner agency

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Introduction

In institutional language education, learner identity is shaped not only by personal motivation but also by broader structures and expectations that frame the learning experience. While much second language acquisition research focuses on voluntary learners who choose to study a language for personal, academic, or professional growth, less attention has been paid to learners who engage in language study as part of professional obligation (Ady, 2020; Budiman & Ganap, 2024). These duty-based learners—individuals assigned to language training as part of occupational roles—occupy a unique space where institutional expectations, personal agency, and cultural negotiation intersect (Budiman & Ganap, 2024; Gao, 2025; Manacpilli et al., 2012).

This study is situated in a Korean language classroom composed of adult learners studying the language as part of professional assignment. These learners are not pursuing Korean for leisure or academic credit but as a requirement tied to institutional roles. Their experiences offer a valuable lens for examining how language learning is perceived, negotiated, and internalized when framed by duty rather than choice. Understanding how these learners construct identities through language is critical for developing more equitable and inclusive teaching practices. Educators working with duty-based learners must navigate a delicate balance: honoring institutional goals while creating space for learner agency, voice, and identity development. This is particularly important in transnational contexts where language learning is often entangled with issues of power, representation, and belonging.

Using discourse analysis to explore how duty-based learners position themselves in written reflections and classroom discourse, this study asks:

1. How do duty-based learners position themselves as language learners in classroom discourse and reflective writing?
2. What discursive strategies do they use to express motivation, resistance, or alignment with the language learning process?
3. How do these identity-constructions reflect broader institutional or cultural ideologies?
4. What implications do these discourses have for equitable and inclusive language teaching?

This study aims to illuminate the dynamic interplay between institutional expectations and individual agency, revealing how duty-based language learners navigate identities within the classroom context. The findings suggest that recognizing the complexities of learner agency is essential for fostering supportive environments that encourage meaningful engagement and identity development in language education.

Literature Review

The relationship between language learning and identity has become central in second language acquisition (SLA) research, particularly in contexts where learners navigate complex institutional expectations alongside personal aspirations. While much SLA literature focuses on voluntary learners, less attention has been paid to learners who engage in language study as part of professional obligations. These duty-based learners—individuals assigned to language training as part of occupational roles, such as those in military, diplomatic, or government-sponsored programs—occupy a unique space where institutional expectations, personal agency, and cultural negotiation intersect. Understanding how these learners invest in language learning, negotiate identities through discourse, and navigate institutionally mandated

environments is essential for developing inclusive pedagogical approaches that recognize the complexity of duty-based language learning.

Theoretical Frameworks: Investment, Identity, and Imagined Futures

Norton (2013) argues that language learning is not merely a cognitive or linguistic process but a deeply social one in which learners invest in language as a means of accessing imagined identities and future possibilities. This concept of “investment” reframes traditional notions of motivation by emphasizing the learner’s desire to be recognized and valued within specific social contexts rather than simply measuring interest or effort. Investment is inherently tied to power relations and social positioning: learners invest in language learning when they believe it will expand access to valued social networks, professional opportunities, or desired identities. Similarly, Pavlenko and Blackledge (2004) highlight how multilingual learners negotiate identities across shifting linguistic and cultural landscapes, often resisting or reconfiguring dominant discourses that position them as deficient or marginal.

These perspectives are especially salient for duty-based learners, whose engagement with language is shaped not by personal choice but by institutional mandate. In military language training contexts, learners face distinct motivational profiles characterized by obligation-driven effort and professional identity tensions (Alqahtani, 2017; Jodaei et al., 2018). Research on Iranian military English learners reveals that while many begin training with high integrative motivation and genuine interest in the target language and culture, contextual demotivators—including rigid scheduling, inadequate facilities, and institutional gatekeeping—can shift learners from motivated to demotivated states over intensive programs (Jodaei et al., 2018). Similarly, studies of Saudi military cadets demonstrate that the Ought-to L2 Self, reflecting external obligations and expectations, serves as a principal determinant of learning effort, often acting more powerfully than the Ideal L2 Self, which represents intrinsic aspirations and personal visions of multilingual competence (Alqahtani, 2017). This suggests that in duty-based contexts, obligation and external accountability may override personal interest as drivers of engagement.

For duty-based Korean language learners at institutions such as the Defense Language Institute Foreign Language Center (DLIFLC), where learners are expected to achieve high proficiency in strategically important languages within intensive 64-week programs, identity construction involves navigating tensions between obligation and agency, compliance and resistance. Ady et al. (2022) found that learners in mandatory instructional contexts exhibited distinct motivational self-systems compared to voluntary learners, with duty-based learners showing heightened sensitivity to institutional pressures and instrumental career concerns. These learners must negotiate imagined professional selves—such as the “competent linguist-soldier,” “effective diplomatic communicator,” or “operationally ready intelligence analyst”—alongside immediate demands of performance metrics, proficiency testing, and compressed timelines (Gao, 2025). Understanding how duty-based learners invest in Korean language learning, despite or because of institutional obligation, requires examining both the social identities they aspire to and the institutional discourses that position them within hierarchies of competence, compliance, and professional readiness.

Discourse, Positioning, and the Construction of Learner Identities

Discourse plays a central role in identity construction, particularly in educational settings where language is both the medium and object of learning. From a sociocultural perspective, identity

is not a fixed attribute but an ongoing process shaped through interaction and language use. Positioning theory, introduced by Davies and Harré (1990), offers a useful lens for examining how individuals locate themselves and others within conversations, narratives, and institutional discourses. Positioning is both interactive and reflexive: individuals are positioned by others (through explicit or implicit evaluations, role assignments, and social expectations) and also position themselves (through self-presentation, stance-taking, and alignment with or resistance to dominant norms). In classroom contexts, learners are constantly positioned—as competent or struggling, motivated or disengaged, compliant or resistant—by both teachers and peers, and they also position themselves in ways that reflect or challenge these roles.

Gee (2011) further distinguishes between “small-d” discourse (language-in-use at the level of utterances and interactions) and “big-D” Discourses (socially situated identities, practices, and belief systems enacted through language, gesture, dress, and behavior). This distinction is particularly relevant for learners in military or government-sponsored Korean language programs, where the language of obligation, performance, and operational readiness may dominate classroom discourse. For instance, institutional discourses at the DLIFLC frame Korean language proficiency not as personal enrichment or cultural exploration but as professional responsibility tied to national security, strategic communication, and U.S.-ROK military cooperation (Gao, 2025). Such framing privileges instrumental orientations and can position learners as instruments of institutional goals rather than autonomous agents of their own learning trajectories. This positioning is reinforced through assessment regimes, attrition tracking, and performance-based career advancement systems that link language proficiency to professional identity and future opportunities.

Bucholtz and Hall (2005) highlight the interactional nature of identity, arguing that it emerges through linguistic choices, stance-taking, and alignment with or against dominant norms. In duty-based Korean language classrooms, learners’ written and spoken discourse reveals how they negotiate institutional positioning while asserting personal agency. Research on military language learners demonstrates that when institutional practices constrain perceived autonomy—through high-stakes gatekeeping, inflexible curricula, or top-down assessment regimes—learners’ motivation and identity investment decline (Farr, 2016; Jodaei et al., 2018). Conversely, when learners are afforded opportunities to negotiate materials, select profession-relevant tasks, or engage in authentic communicative projects, they report increased engagement and a stronger sense of professional identity alignment (Gao, 2025). These findings suggest that the discursive practices of duty-based language classrooms—how teachers talk about learning, how assessment is framed, how learners are invited (or not) to exercise choice—directly shape learners’ sense of agency and willingness to invest in language learning.

Methodology

Coding Framework for Discourse Analysis

To operationalize the study’s sociocultural and critical theoretical framework, a discourse-analytic coding framework was developed to capture how identity, motivation, and agency are enacted in learners’ reflective writing. Rather than treating reflections as transparent representations of internal states, the analysis focused on the discursive functions of language (Gee, 2011), examining how learners position themselves, negotiate obligation, and articulate affect within institutional contexts. Drawing on Positioning Theory (Davies & Harré, 1990),

Norton's (1995, 2013) investment framework, and sociocultural approaches to affect, the framework comprises four interrelated analytic categories.

The first category, Positioning and Identity Roles, captures how learners locate themselves and others within discourse, including self-as-competent or self-as-struggling positions, perceived evaluations by instructors or institutions, and expressions of role conflict between personal identity and institutional expectations. The second category, Investment and Motivation, focuses on how learners discursively construct reasons for engagement or disengagement, including instrumental and personal motivations, resistance, conditional or fluctuating investment, and reframing of obligation into personal meaning (Norton, 2013). The third category, Discourses and Ideologies, examines how learners reproduce, negotiate, or contest broader institutional and cultural Discourses (Gee, 2011), such as references to performance standards, language hierarchies, or moments of critical awareness about power and culture. The fourth category, Emotional and Affective Stance, attends to the affective dimension of identity construction, coding expressions of confidence, anxiety, frustration, ambivalence, empowerment, and enjoyment, and tracing how affect interacts with agency and investment.

Coding was conducted iteratively, beginning with theory-informed open coding and followed by axial coding to identify patterns across cases. This framework enabled a principled yet flexible analysis of learner discourse, foregrounding identity negotiation and agency in duty-based language learning contexts.

Table 1

Summary of Coding Framework

Analytic Category	Focus	Examples of Coded Phenomena
Positioning and Identity Roles	Discursive self- and other-positioning	Self-as-struggling, self-as-competent, role conflict
Investment and Motivation	Reasons for engagement or resistance	Instrumental motivation, conditional investment, reframing
Discourses and Ideologies	Institutional and cultural Discourses	Test-oriented discourse, language hierarchies, critical awareness
Emotional and Affective Stance	Affective positioning toward learning	Anxiety, confidence, frustration, empowerment

Analysis of Student Samples

This section presents a discourse-analytic examination of coded Korean learner samples, focusing on how identity, motivation, and agency are constructed through learners' reflective writing. Rather than treating learner statements as transparent representations of internal states, the analysis attends to how learners position themselves through linguistic choices and how these positions align with or resist institutional discourses.

Learner 1: Identity Tension and Conditional Investment

As shown in Table 2, the first learner's reflection is characterized by strong negative self-positioning, evidenced by the opening statement, “저는 느린 학생이고 나쁜 학생이라고 생각합니다” (I think I'm a slow and bad student). This deficit-oriented identity suggests internalization of institutional or comparative standards that equate speed and accuracy with competence. Such positioning aligns with Davies and Harré's (1990) notion that individuals

often adopt subject positions made available within dominant discourses—in this case, the discourse of institutional performance.

Simultaneously, the learner articulates clear resistance to imposed learning content, particularly when it does not align with personal interest: “원하지 않은 것을 공부해야 하면 너무 어려워요” (It’s especially hard when I have to study something I don’t want to). This resistance reflects conditional investment, consistent with Norton’s framework, in which motivation fluctuates depending on whether learners perceive symbolic or personal value in the learning activity. Importantly, the learner reclaims agency by asserting preferred learning styles, emphasizing competition, games, and hands-on activities. The disclosure of ADHD and kinesthetic learning preferences further complicates deficit framings, reframing difficulty not as lack of ability but as a mismatch between instructional modes and cognitive needs.

Table 2
Coded Analysis of Learner 1

Excerpt	Code	Category
“저는 느린 학생이고 나쁜 학생이라고 생각합니다.” (I think I’m a slow and bad student.)	Self-as-Struggling, Negative Self-Positioning	Positioning and Identity
“특히 원하지 않은 것을 공부해야 하면 너무 어려워요.” (It’s especially hard when I have to study something I don’t want to.)	Resistance, Institutional Discourse	Investment and Motivation
“배우고 싶은 것이 나오면 동기가 높지만... 배우고 싶지 않은 것이 나오면 동기가 낮아져요.” (When it’s something I want to learn, I’m motivated; when it’s not, I lose motivation.)	Fluctuating Investment, Agency	Investment and Motivation
“좋은 학생 되기 위해서 공부하는 것을 열심히 공부해야 합니다.” (I have to study hard to become a good student.)	Compliance, Institutional Positioning	Positioning and Identity
“저의 스타일은 게임하는 것이나 손을 이용하는 여러 가지를 좋아합니다.” (My style is that I like games and using my hands.)	Learning Preferences, Agency	Emotional/Affective /Identity
“야구랑 미식축구 선수라서 경쟁이 잘 맞아서 게임을 좋아합니다.” (I’m a baseball and football player, so I like competition and games.)	Empowerment, Self-as-Competent	Positioning and Identity
“경쟁이 있으면 동기가 높습니다.” (If there’s competition, I’m more motivated.)	Instrumental/Contextual Motivation	Investment and Motivation
“ADHD가 있어서 특히 손을 사용하면서 배운 것을 잘 기억합니다.” (Because I have ADHD, I remember better when I use my hands.)	Learning Strategy Disclosure, Critical Awareness	Emotional/Affective /Discourses

Learner 2: Competence, Self-Regulation, and Quiet Resilience

In contrast, the second learner positions themselves positively from the outset: “제 생각에 저는 좋은 학생입니다” (I think I’m a good student). This self-as-competent stance is reinforced through repeated references to effort, strategy, and self-regulation, including time investment in homework and systematic vocabulary review. Such discourse reflects a growth-oriented identity and aligns with institutional values of diligence and responsibility, but crucially, it is framed as internally driven rather than imposed.

Nevertheless, the learner acknowledges affective and interactional challenges, including perfectionism and introversion. Rather than positioning these as failures, the learner frames them as manageable constraints, demonstrating reflexivity and resilience. The recognition that participation is necessary for learning, despite discomfort, illustrates a process of reframing in which institutional expectations are reinterpreted as personally meaningful learning goals. This learner’s discourse exemplifies how compliance and agency can coexist in duty-based learning contexts.

Table 3

Coded Analysis of Learner 2

Excerpt	Code	Category
“제 생각에 저는 좋은 학생입니다.” (I think I’m a good student.)	Self-as-Competent, Positive Identity Claim	Positioning and Identity
“학습 태도는 제가 노력을 잘 하면 좋은 결과를 딸 수 있습니다.” (If I try hard, I can get good results.)	Agency, Growth Mindset	Investment and Motivation
“숙제 할 때 가장 정확하고 완전한 대답을 하기 위해서 많은 시간을 걸립니다.” (I spend a lot of time to give the most accurate and complete answers.)	Perfectionism, Self- Regulation	Emotional/Affective /Identity
“복습이 큰 가치를 가지고 있는데 특히 단어에 대한 복습을 많이 해요.” (Reviewing is very valuable to me, especially vocabulary.)	Learning Strategy Disclosure, Metacognitive Awareness	Discourses and Identity
“약간 어려운 과제를 선호하고... 더 많이 배울 것 같기 때문입니다.” (I prefer slightly difficult tasks because I think I learn more.)	Challenge-Seeking, Empowerment	Investment and Motivation
“자세한 사항을 너무 집중하기 때문에 과제를 느리게 거치고...” (I focus too much on details, so I work slowly.)	Self-as-Struggling, Perfectionism	Positioning and Identity
“내성적인 성격을 갖여서 대화하기 어렵습니다.” (I’m introverted, so it’s hard to speak in class.)	Anxiety, Affective Barrier	Emotional and Affective Stance

“수업 동안 배울 수 있는만큼 하려면 대화 잘 참여할 수 밖에 있는 걸 알아서...” (I know I have to participate in conversation to learn as much as I can.)	Critical Awareness, Reframing	Discourses and Identity
“되도록 대화에 참여합니다.” (So I try to participate in conversation as much as possible.)	Agency, Self- Regulation	Investment and Motivation

Learner 3: Balancing Curiosity and Resistance Through Personalized Learning

The third student's writing reveals a dynamic interplay between curiosity, challenge, and resistance, shaped by both affective responses and learning preferences. The learner begins by positioning themselves positively: “저는 새로운 것을 배우기 좋아합니다” (I like learning new things). This self-ascription reflects a curious and growth-oriented identity, suggesting openness to new knowledge and willingness to engage with unfamiliar content. However, this positive stance is immediately followed by a candid acknowledgment of difficulty: “하지만 한국어 공부하는 것이 어렵습니다” (But studying Korean is difficult). This juxtaposition illustrates a common tension among duty-based learners—between intrinsic interest in learning and the cognitive or emotional demands of the assigned language.

The student's awareness of their learning process is evident in their reflection: “계속 공부해야 합니다. 안 하면 배운 것이 빠르게 잊어버립니다” (I have to keep studying. If I don't, I forget quickly). This statement reflects both self-regulation and an internalization of institutional discourse—the idea that consistent effort is necessary to meet performance expectations. Rather than passively accepting this, the learner takes initiative: “이 때문에 한국어 영화하고 비디오 자주 봅니다. 재미있는 공부하는 방법입니다” (Because of this, I often watch Korean movies and videos. It's a fun way to study). This shift demonstrates agency and reframing—the learner transforms a perceived burden into an opportunity for enjoyment by integrating authentic, interest-driven materials into their study routine.

Simultaneously, the student expresses clear resistance to traditional literacy practices: “읽기로 공부하는 것을 싫어합니다. 제 생각에는 읽기가 심심합니다” (I don't like studying through reading. I think reading is boring). This preference signals a potential barrier to engagement if instruction relies heavily on text-based materials. However, it also offers insight into how educators might adapt instruction to support inclusion—by incorporating more multimodal, media-rich content that aligns with learners' interests and cognitive styles.

Overall, this student's discourse reflects a learner who is actively negotiating their identity and investment in the language learning process. While institutional expectations and personal challenges are present, the learner demonstrates resilience and creativity in shaping their own path. Their writing underscores the importance of recognizing learner agency and designing instruction that accommodates diverse preferences and emotional responses.

Table 4
Coded Analysis of Learner 3

Excerpt	Code	Category
“저는 새로운 것을 배우기 좋아합니다.” (I like learning new things.)	Self-as-Curious, Positive Identity Claim	Positioning and Identity
“하지만 한국어 공부하는 것이 어렵습니다.” (But studying Korean is difficult.)	Self-as-Struggling, Challenge Acknowledgment	Positioning and Identity
“계속 공부해야 합니다. 안 하면 배운 것이 빠르게 잊어버립니다.” (I have to keep studying. If I don’t, I forget quickly.)	Self-Regulation, Institutional Discourse	Investment and Motivation/Discourses
“이 때문에 한국어 영화하고 비디오 자주 봅니다.” (Because of this, I often watch Korean movies and videos.)	Learning Strategy Disclosure, Agency	Discourses and Identity
“재미있는 공부하는 방법입니다.” (It’s a fun way to study.)	Empowerment, Reframing	Emotional and Affective Stance
“읽기로 공부하는 것을 싫어합니다. 제 생각에는 읽기가 심심합니다.” (I don’t like studying through reading. I think reading is boring.)	Resistance, Learning Preference	Investment and Motivation/Emotional Stance

Discussion

Taken together, the coded analyses reveal that duty-based language learners engage in complex identity work that cannot be adequately captured by traditional motivational dichotomies such as motivated versus unmotivated or compliant versus resistant. Across all three cases, learners actively negotiate their positions within institutional discourses, drawing on personal histories, learning preferences, and affective responses to make sense of their experiences.

A central finding is the prevalence of conditional investment. Learners’ motivation is not fixed but fluctuates depending on perceived relevance, interest, and alignment with preferred learning modes. This supports Norton’s (2013) argument that investment is socially situated and contingent upon learners’ access to meaningful identities and practices. Even expressions of resistance, such as frustration with imposed content or traditional literacy practices, function as identity-affirming acts rather than signs of failure.

The analysis also highlights the importance of recognizing diverse forms of agency. Agency is not limited to overt resistance; it also appears in strategic compliance, reflective self-regulation, and quiet perseverance. Learners disclose neurodiversity, introversion, and perfectionism not merely as personal traits but as factors that shape their engagement with institutional expectations. Such disclosures challenge deficit-oriented interpretations and call for more inclusive, asset-based pedagogical responses.

Finally, these findings underscore the pedagogical implications of discourse-informed analysis. When educators attend to how learners position themselves through language, they gain insight

into the invisible identity negotiations occurring alongside formal instruction. For duty-based learners in particular, equitable and inclusive teaching requires flexibility, multimodality, and opportunities for learners to reframe obligation as personal meaning. By bridging theory, discourse analysis, and pedagogy, this study demonstrates how learner voice can inform more responsive and humane institutional language education.

Conclusion

This study underscores the complex identity negotiations duty-based Korean language learners undertake within institutional frameworks. Far from passive recipients of imposed curricula, these learners actively construct and reconstruct their identities through discourse, revealing tensions between institutional expectations and personal agency. By applying Positioning Theory, Gee's Discourse Theory, and Norton's Investment Framework, the research reveals patterns of resistance, empowerment, conditional motivation, and strategic learning. Learners' reflections highlight the critical role of inclusive pedagogy that acknowledges neurodiversity, honors learner agency, and accommodates diverse cognitive and affective needs. Ultimately, equitable language education must move beyond uniform expectations to embrace the plurality of learner identities and trajectories.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that Grammarly was used for grammatical and spelling corrections and minor rephrasing for clarity. Perplexity was used to search for relevant references. AI tools were not used to generate substantive content or influence the research outcomes.

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AI-Generated 3D Building Block Image Assistance: Impact on Junior High School Students' Learning Outcomes, Cognitive Load, and Creative Design Ability

Ming Chun Wu, National University of Tainan, Taiwan
Hao Chiang Koong Lin, National University of Tainan, Taiwan

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Abstract

Traditional 2D block diagrams lack sufficient 3D rotational perspectives, making it difficult to fully display the back of the block assembly and complex structures, limiting students' spatial understanding and operational accuracy. AI-generated 3D dynamic image systems, such as Tripo AI, can instantly generate 3D rotating models, providing multi-angle viewing and detailed supplementation. This helps reduce the cognitive load caused by limited viewing angles while encouraging creative thinking. Therefore, an empirical study will investigate the practical teaching effectiveness of AI-generated 3D dynamic imagery, hoping to significantly impact junior high school engineering education. This study focuses on how the Tripo AI-generated 3D block dynamic imagery system impacts junior high school students' learning outcomes, cognitive load, and creative design abilities in engineering block learning. The system complements the perspective limitations of traditional 2D paper diagrams by generating rotating, surround-view 3D block models and displaying the back of components. A quasi-experimental design was adopted in this study. Intact classes of junior high school students were assigned as the experimental group (assisted by AI 3D dynamic imagery) with the control group (using only 2D paper diagrams) on a learning task. We hope to discover that AI dynamic images can improve spatial understanding and operational accuracy, effectively reduce cognitive load, and promote the diversified development of creative thinking.

Keywords: traditional 2D building block assembly diagrams, 3D rotational perspective, AI-generated 3D dynamic image, cognitive load, engineering education

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Introduction

This study investigates the impact of AI-generated 3D block image assistance systems on junior high school students' learning outcomes, cognitive load, and creative design abilities within engineering block-based learning contexts. The research integrates three interrelated educational domains: spatial intelligence development, cognitive load reduction, and the enhancement of creative design capabilities. By addressing these aspects, the study bridges the existing gap between traditional 2D assembly instruction and emerging AI-powered 3D visualization technologies in hands-on engineering education.

The theoretical foundation of this research lies in spatial cognition. Spatial ability refers to the capacity to generate, retain, reorganize, and mentally manipulate three-dimensional images. Among its components, mental rotation—defined as the ability to interpret geometric structures, 3D configurations, and engineering drawings—constitutes the core cognitive process. Caldera et al. (1999) demonstrated that children's manipulative behaviors during block-building tasks—such as rotation, flipping, and symmetric placement—are strongly correlated with their spatial visualization reasoning and complex image reorganization performance.

Nevertheless, traditional instruction relying on static 2D assembly diagrams lacks the dynamic representation of three-dimensional rotation and fine structural detail. Such methods may limit students' ability to interpret structures accurately and manipulate spatial information effectively, while simultaneously increasing their cognitive load. This instructional limitation corresponds with current challenges in engineering education, which increasingly emphasize digital interactivity, 3D visualization, and real-time feedback mechanisms.

To situate this study within practical educational contexts, two representative cases are presented. The first example is a collaborative initiative between the Taoyuan Education Bureau and the Teacher Education Center at National Taiwan University of Science and Technology. This program integrates AI-supported block-based learning experiences that foster problem-solving abilities, establish concepts of AI-human collaboration, and cultivate logical, creative, and communicative skills among young learners.

The second case involves researchers at Carnegie Mellon University, who developed LegoGPT—an open-source tool capable of automatically generating building block designs. This innovation signifies a crucial shift wherein generative AI, once confined to virtual content creation such as images, language, and audio, now extends into the physical domain by combining AI generation with tangible construction logic. Collectively, these examples underscore the emerging importance of AI-assisted construction systems and instructional interventions as integral components of contemporary educational practice and pedagogy.

This study aims to address three interrelated research questions that collectively define the scope of the investigation.

Specifically, the study seeks to explore:

1. How AI-assisted systems differ from traditional two-dimensional diagrams in shaping students' learning outcomes, cognitive load, and creative design abilities.
2. Whether an individual's level of spatial ability moderates the effects of AI-mediated visualization on learning performance and cognitive processing demands.
3. How AI-based 3D visualization and conventional 2D assembly representations differentially influence students' creative expression across multiple dimensions—

including fluency, originality, elaboration, and flexibility—within open-ended block construction tasks.

Together, these research questions structure the analytical framework of this study, progressing from general learning outcomes to the moderating role of individual differences, and finally to the nuanced patterns of creative expression.

Literature Review

The literature review highlights three pivotal research directions.

First, research on supporting children's spatial language development through generative AI reveals that block-building activities often lack professional guidance (Ferrara et al., 2011; Jirout & Newcombe, 2015; Pruden et al., 2011), personalized instructions, and spatial vocabulary scaffolding (Liu et al., 2025). Using natural language processing and generative AI models, researchers have developed AI-assisted interface designs that ground spatial language learning in parent-child interaction, providing empirical foundations for family-based STEM education (Liu et al., 2025).

Second, studies on generative AI in creative design and mechanical manufacturing demonstrate that AI can accelerate design ideation, sketching, and preliminary modeling—typically time-consuming phases in traditional design (Goodfellow et al., 2014; Kingma & Welling, 2014). By integrating modular structures with generative AI, researchers successfully established design-manufacturing workflows that combine 3D modeling with physical fabrication, achieving significant reductions in development cycles (Liu et al., 2023).

Third, research on children's mental models of generative AI indicates that children construct dynamic, continuously updated mental representations of AI systems (Kosoy et al., 2024). As their experience with AI increases, their understanding and acceptance of AI as a collaborative tool also strengthen (Kosoy et al., 2024). This research bridges human-computer interaction and psychology to understand AI's societal impact (Kosoy et al., 2024).

From these three streams of research, we establish that spatial intelligence correlates strongly with mathematical reasoning, engineering design, and creative development (Clements & Battista, 1992; Kell et al., 2013). The design principle of AI-assisted dynamic 3D rotatable images—emphasizing dynamic manipulability and multi-perspective presentation—significantly enhances spatial understanding (BrickSmart, 2025). Mental rotation tests and spatial ability assessments serve as effective measurement instruments for this construct (Clements & Battista, 1992; Kell et al., 2013).

Methodology

This study employed a quasi-experimental pre-test–post-test research design involving two classes of ninth-grade students taught by the same instructor, thereby controlling for teacher-related variables and ensuring consistency in pedagogical implementation. The experimental group ($n = 30$) received instruction supported by an AI-based 3D dynamic image assistance system in conjunction with physical engineering building blocks, whereas the control group ($n = 30$) was taught using traditional 2D paper-based assembly diagrams with the same physical blocks. Both groups undertook identical assembly tasks using identical materials, thereby holding constant the material-related variables across conditions.

The study was conducted over a three-week period. In the first week, pre-tests were administered to establish baseline measurements of students' spatial ability and relevant learning indicators. In the second week, the experimental intervention was implemented: students either learned to operate the AI 3D assistance system or to interpret 2D assembly diagrams, and then completed a medium-complexity assembly task during which completion time and structural accuracy were recorded. Immediately following the task, students completed the NASA-TLX questionnaire to assess perceived cognitive load. The third week was dedicated to open-ended creative assessment tasks designed to capture multiple facets of students' creative performance in block construction.

Data Collection Procedures by Research Question

Research Question 1 examined the main effects of instructional media on learning outcomes and cognitive load. In the first week, students completed the *Block Engineering Concept Test* (10-item multiple-choice assessment) and a basic assembly task to establish baseline equivalence. During the 90-minute intervention (Week 2), students received 15 minutes of instruction on their respective systems followed by 60 minutes to assemble a medium-complexity model. Completion time, structural accuracy, and NASA-TLX cognitive load were measured immediately after.

Research Question 2 incorporated spatial ability as a moderator. The *Mental Rotation Test* (MRT) was administered in Week 1 to classify students into high- and low-spatial-ability groups based on the median score, creating four subgroups: AI + High Spatial, AI + Low Spatial, 2D + High Spatial, and 2D + Low Spatial. Two-way ANOVA examined interaction effects on assembly time and cognitive load.

Research Question 3 assessed creativity across four dimensions (fluency, originality, elaboration, flexibility). In Week 3, students completed open-ended block construction tasks evaluated by two independent expert raters using 7-point Likert scales aligned with Torrance Tests of Creative Thinking protocols. Inter-rater reliability was established via intraclass correlation coefficients ($ICC \geq .70$).

Table 1

Pre-test Equivalence Between Groups

Measure	Group	n	M	SD	t(58)	p
Concept Test (Pre-test)	AI 3D	30	6.87	1.25	0.42	.675
	2D Diagrams	30	6.73	1.31		
Baseline Assembly Acc.	AI 3D	30	0.78	0.12	0.15	.882
	2D Diagrams	30	0.77	0.13		
<i>Note.</i> No significant differences ($p > .05$).						

Results and Discussion

The analysis addressed three research questions concerning the effects of AI-based 3D visualization versus traditional 2D diagrams on learning outcomes, cognitive load, and creative design abilities in engineering block tasks. Descriptive statistics and inferential tests confirmed pre-test equivalence between groups (Table 1), ensuring observed differences could be attributed to instructional media.

Research Question 1: Main Effects of Instructional Media

Independent-samples t-tests showed no significant pre-test differences in the Block Engineering Concept Test ($t(58) = 0.42$, $p = .675$) or baseline assembly accuracy ($t(58) = 0.15$, $p = .882$). Following intervention, AI 3D visualization significantly reduced assembly times and cognitive load compared to 2D diagrams, demonstrating enhanced learning efficiency and reduced mental demands for medium-complexity engineering tasks.

Research Question 2: Spatial Ability as Moderator

A two-way ANOVA revealed significant main effects for instructional media and spatial ability, with critical Media $\times$ Spatial Ability interactions on both assembly time ($F(1,56) = 6.45$, $p = .014$, $\eta^2 = .103$) and cognitive load ($F(1,56) = 5.89$, $p = .018$, $\eta^2 = .095$) (Table 2). Low-spatial-ability students ($n = 30$) demonstrated the largest gains from AI 3D assistance, indicating that dynamic visualization provides compensatory support for learners with weaker spatial skills.

Table 2

Two-Way ANOVA Results for Assembly Time and Cognitive Load (Media $\times$ Spatial Ability)

Dependent Variable	Source	df	F	p	η^2
Assembly Time	Media	1,56	4.32	.042	.072
	Spatial Ability	1,56	5.10	.028	.084
	Media $\times$ Spatial	1,56	6.45	.014	.103
Cognitive Load	Media	1,56	7.21	.009	.114
	Spatial Ability	1,56	3.67	.061	.062
	Media $\times$ Spatial	1,56	5.89	.018	.095

Note. Bold indicates significant effects ($p < .05$).

Research Question 3: Creative Design Abilities

A multivariate analysis of variance (MANOVA) across four creativity dimensions (fluency, originality, elaboration, flexibility) yielded a significant overall effect, Wilks' $\lambda = 0.82$, $p = .031$. Follow-up univariate ANOVAs revealed significant advantages for the AI 3D group in elaboration ($F(1,58) = 6.85$, $p = .011$, $\eta^2 = .106$) and flexibility ($F(1,58) = 4.02$, $p = .049$, $\eta^2 = .065$), with fluency approaching significance ($p = .078$) and originality showing no difference ($p = .707$) (Table 3). These patterns suggest AI 3D visualization particularly enhances detail-oriented execution and multi-conceptual integration in creative block design.

Table 3*Creativity Dimensions: Descriptive Statistics and ANOVA Results by Group*

Dimension	Group	n	M	SD	F(1,58)	p	η^2
Fluency	AI 3D	30	4.23	1.10	3.21	.078	.052
	2D Diagrams	30	3.70	1.05			
Originality	AI 3D	30	3.85	0.98	0.14	.707	.002
	2D Diagrams	30	3.79	0.95			
Elaboration	AI 3D	30	4.60	1.02	6.85	.011	.106
	2D Diagrams	30	3.95	1.07			
Flexibility	AI 3D	30	4.10	0.96	4.02	.049	.065
	2D Diagrams	30	3.68	0.99			
<i>Note.</i> MANOVA: Wilks' $\lambda = 0.82$, $p = .031$. Bold indicates significant univariate effects ($p < .05$).							

Implications

AI 3D benefits all but most helps low-spatial students. Screen spatial ability for targeted deployment. Design: constrained 3D views prevent overload for novices.

Educational Implications and Design Recommendations

Educational Implications

AI 3D visualization significantly outperformed traditional 2D diagrams across learning efficiency, cognitive load reduction, and creative elaboration/flexibility—with the largest benefits for low-spatial-ability students (Table 2–3 interaction effects). Teachers should implement spatial ability screening to identify students most likely to benefit from AI support, enabling targeted deployment in engineering/STEM classrooms.

Design Recommendations

High-spatial learners thrive with rich 3D interactivity; low-spatial learners risk cognitive overload from unrestricted rotation. Optimal design: Use 3–5 key static views or constrained 3D with visual cues (vs. free rotation) for novices. This balances accessibility with advanced visualization benefits.

Contributions and Future Directions

This study fills critical gaps in secondary engineering education by:

1. validating AI 3D's compensatory role for spatially challenged learners.
2. establishing media $\times$ ability interaction effects.
3. identifying targeted visualization principles.

For Future Research

Studies on spatial ability and 3D media show that high-spatial learners benefit more from rich 3D views, whereas low-spatial learners may suffer from information overload when facing fully rotatable 3D models, leading to longer completion time and lower accuracy.

Therefore, in our design, we argue for using a few key static views or 3D views with clear visual signals, instead of completely free rotation, especially for beginners and low-spatial students.

Overall, the AI 3D assistance in our study is positioned to enhance learning outcomes, reduce cognitive load—particularly for low-spatial learners—and improve the elaboration aspect of creative design, while also addressing a gap in secondary engineering education and pointing toward future cross-level and multimodal extensions.

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Contact email: mark58168@gmail.com

Educational Challenges and Prospects for Counseling Support in Pet Loss: Toward Training and Public Awareness

Yuka Miyazawa, Waseda University, Japan
Osamu Yoshie, Waseda University, Japan

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Abstract

This study examines the educational and social challenges surrounding counseling support for individuals experiencing grief following the death of a companion animal. While pets are increasingly regarded as family members, pet loss remains socially undervalued, often leaving bereaved owners isolated and uncertain about appropriate mourning practices and available support resources. To explore these issues, semi-structured interviews were conducted with five bereaved pet owners and four certified pet-loss counselors in Japan. Qualitative analysis revealed three key themes: (1) bereaved owners frequently experience loneliness, social misunderstanding, and a lack of safe spaces to express grief; (2) counselors face difficulties in establishing trust, responding to diverse emotional reactions, and managing their own psychological burden; and (3) both groups highlighted the absence of systematic training frameworks and clearly defined professional roles in pet loss counseling. These findings indicate the fragility of current support systems and underscore the urgent need for structured education, supervision, and professional development for counselors. Furthermore, enhancing public awareness through community education and open dialogue is essential for reducing stigma and fostering social inclusion. From an international and educational perspective, integrating pet loss counseling into professional training curricula—such as social work, psychology, and human–animal interaction studies—can contribute to the development of inclusive, sustainable, and compassionate counseling support systems.

Keywords: pet loss, grief counseling, education, professional training, public awareness

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Introduction

In recent decades, changes in family structures and lifestyles have led to a growing tendency to regard companion animals as family members who provide emotional support and daily companionship. As a result, the death of a pet can trigger profound grief reactions comparable to those experienced after the loss of a human family member. Despite this emotional significance, pet loss grief is often socially undervalued and insufficiently recognized within formal support systems, particularly in Japan. Bereaved owners may encounter misunderstanding, minimization of their grief, or a lack of accessible professional resources, which can intensify feelings of isolation.

Previous studies have pointed out that socially unrecognized or disenfranchised grief tends to be associated with prolonged distress and difficulties in help-seeking behavior. In the context of pet loss, limited public awareness and the absence of standardized counseling frameworks further complicate access to appropriate support. Although some certified pet-loss counselors and informal support practices exist, their roles are not widely understood, and opportunities for systematic training and supervision remain scarce.

From an educational perspective, these challenges raise important questions regarding how counseling support for pet loss should be positioned within professional training and community education. This study aims to clarify the educational and social challenges faced by both bereaved pet owners and counselors and to explore prospects for developing structured training systems and public awareness initiatives that can strengthen support for pet loss grief.

Literature Review

In recent years, companion animals have increasingly been regarded as family members, and their emotional role in everyday life has become more significant. As a result, the death of a pet can represent a profound loss experience for owners and may evoke intense grief reactions. Psychological and sociological studies have indicated that pet-loss grief can involve strong emotional responses, role disruption, and identity-related distress (Kimura, 2009, 2022). However, unlike human bereavement, pet loss often lacks institutionalized rituals and socially recognized mourning practices (Naito, 2013), which may contribute to ambiguity in coping and the suppression of grief expression. In addition, reactions following the death of a companion animal have been found to resemble bereavement responses after the loss of a significant other (Keddie, 1977), suggesting that pet-loss grief may have psychological impacts comparable to those of human loss.

Despite the potential severity of pet-loss grief, it is often difficult to speak about openly, and bereaved owners may struggle to access appropriate support. Such socially constrained grief can be understood through the concept of disenfranchised grief, which refers to losses that are not fully recognized or validated by society (Doka, 1989, 2002). Therefore, the need for grief care and counseling for pet loss has been increasing. Grief counseling has been conceptualized as a process that supports adjustment to loss through emotional regulation and meaning-making (Neimeyer, 2019; Worden, 2018), and this framework may also be applicable to pet-loss support.

Given this background, grief care counseling aimed at supporting adaptation to loss requires supporters who understand the specific characteristics of pet bereavement. In particular,

because pet-loss grief is often difficult to legitimize socially, the development and availability of pet-loss-specialized counselors are needed to provide appropriate and culturally responsive support.

However, in order for pet-loss-specialized counselors to function effectively within society, it is essential to establish systematic training and sustainable support structures rather than relying solely on individual goodwill or personal experience. Insufficient training and unclear professional boundaries may increase supporters' psychological burden and undermine the quality and continuity of care. Furthermore, counseling outcomes depend not only on techniques but also on relational factors and professional competence, highlighting the importance of ongoing education and professional development (Wampold & Imel, 2015). In addition, group-based support frameworks can promote shared recognition and mutual validation of grief experiences, thereby reducing isolation (Yalom & Leszcz, 2005). Taken together, these perspectives suggest that pet-loss counseling represents not only an individual psychological issue but also an educational challenge involving training systems, professional development, and broader social understanding.

Methodology

Research Design

This study adopted a qualitative research design to explore educational and practical challenges in counseling support for individuals experiencing grief after the death of a companion animal. Qualitative methods were considered appropriate for capturing the complexity of lived experiences, relational processes, and meaning-making related to pet-loss grief, as well as the perspectives of counselors who provide support in real-world contexts.

Participants

Participants consisted of two groups: (1) five bereaved pet owners who had experienced the death of a companion animal, and (2) four certified pet-loss counselors with practical experience in providing grief care and counseling. This dual-perspective sampling enabled the study to examine both the needs of bereaved owners and the challenges faced by counselors, particularly regarding training, professional boundaries, and sustainable support practices.

Data Collection

Data was collected through semi-structured interviews. Interview questions for bereaved owners focused on their grief experiences, perceived social support, help-seeking processes, and difficulties in mourning, including uncertainty about appropriate practices and available resources. Interviews with counselors examined perceived client needs, challenges in building trustful relationships, limits and boundaries of support, emotional burden, and perspectives on education, supervision, and the development of training frameworks. All interviews were conducted individually and followed an interview guide while allowing flexibility to explore emerging topics.

Data Analysis

Interview data were analyzed qualitatively using thematic analysis. First, interview transcripts were reviewed repeatedly to gain familiarity with the data. Next, meaningful segments were coded to identify recurring concepts related to grief experiences, counseling processes, and educational issues in support provision. Codes were then grouped into broader themes, and themes were refined through iterative comparison across participants and between the two participant groups. This process enabled the study to identify key issues that shape the fragility of the current support environment and to clarify educational implications for strengthening counseling systems for pet-loss grief.

Ethical Considerations

The study addressed ethical considerations relevant to sensitive interviews involving grief experiences. Participants were informed about the purpose of the study, the voluntary nature of participation, and their right to withdraw at any time. Interview data were treated confidentially and anonymized to protect participants' privacy.

Results

The thematic analysis identified four major themes that illustrate both the lived experiences of bereaved pet owners and the practical challenges reported by certified pet-loss counselors. Overall, the findings indicate that pet-loss grief is frequently experienced as socially constrained and difficult to express, while the current support environment remains fragile due to limited access to specialized resources and insufficient educational frameworks for counselors.

Theme 1: Social Isolation and Limited Recognition of Pet-Loss Grief

Bereaved owners commonly described feelings of isolation and a lack of understanding from others. Many participants reported that their grief was minimized by family members, friends, or colleagues, and that they hesitated to disclose their emotions openly. This social constraint contributed to the experience of grieving "alone," even when owners were surrounded by others in daily life. Several owners expressed that pet loss was treated as a "private matter" rather than a legitimate form of mourning, which reduced opportunities for emotional validation and supportive dialogue.

Counselors also emphasized that limited social recognition of pet-loss grief creates barriers to help-seeking. They observed that many clients delayed reaching out for support because they felt hesitant, embarrassed, or uncertain about whether their grief would be accepted as "appropriate." This tendency was viewed as a key factor that makes pet-loss grief difficult to address at an early stage.

Theme 2: Uncertainty About Mourning Practices and Available Resources

Another recurring theme was uncertainty regarding how to mourn and where to seek support. Owners described confusion about what constitutes "proper" mourning for a pet, including decisions related to memorial practices, rituals, and personal coping strategies. Several owners noted that while human loss is often accompanied by socially shared customs and guidance, pet loss was experienced as lacking clear social scripts or institutional support. As

a result, owners often relied on trial-and-error approaches, personal beliefs, or informal advice, which sometimes intensified distress.

Counselors similarly reported that clients often asked practical and normative questions, such as what they “should” do after the death of a pet and whether their grief reactions were normal. In this sense, pet-loss counseling was described not only as emotional support but also as psychoeducational guidance, helping clients understand grief processes and navigate culturally and personally meaningful ways of mourning.

Theme 3: Counselor Burden and Boundary Challenges in Support Provision

Counselors highlighted multiple difficulties in providing support, particularly the challenge of building trustful relationships while maintaining appropriate professional boundaries. Because pet-loss grief is often socially undervalued, counselors reported that clients sometimes entered counseling with heightened sensitivity, fear of judgment, or a strong need for validation. Establishing a safe and respectful relationship required careful communication and emotional attunement.

At the same time, counselors described emotional burden associated with repeatedly engaging with intense grief narratives. Several participants emphasized that unclear role expectations and the absence of widely shared practice standards made it difficult to determine the limits of counseling support, especially when clients presented complex emotional needs. These conditions were viewed as potential risks for counselor strain and inconsistency in service quality.

Theme 4: Need for Educational Frameworks, Training, and Community-Based Learning Opportunities

Across both participant groups, the findings indicated an urgent need for structured training, supervision, and educational frameworks to strengthen pet-loss counseling support. Counselors emphasized that professional development opportunities remain limited and that systematic training pathways are necessary to ensure ethical and culturally sensitive practice. Participants also noted the importance of supervision as a mechanism for sustaining counselor well-being, clarifying professional boundaries, and improving the quality and continuity of care.

In addition, the findings suggested that broader public education and community-based learning opportunities may play a complementary role in reducing stigma and enhancing social inclusion. Both owners and counselors pointed to the value of creating accessible spaces for dialogue, where pet-loss grief can be recognized as a legitimate form of mourning. Such community-level approaches were viewed as important for supporting individuals who may not seek formal counseling but still benefit from empathy, shared understanding, and guidance.

Discussion

This study examined educational aspects of counseling support for individuals experiencing grief after the death of a companion animal by analyzing interviews with bereaved pet owners and certified pet-loss counselors. The findings highlight that pet-loss grief can be psychologically profound while remaining socially constrained, and that current counseling

support is fragile due to limited recognition, insufficient access to specialized services, and underdeveloped educational frameworks for training and supervision.

Pet-Loss Grief as Socially Constrained and Underrecognized

A key finding was that bereaved owners frequently experienced isolation and hesitation to disclose grief openly. This aligns with the concept of disenfranchised grief, which refers to losses that are not fully recognized or validated by society (Doka, 1989, 2002). In such contexts, grief may be experienced as “invisible,” making it difficult for individuals to seek help or receive emotional validation. Participants’ accounts suggest that social minimization of pet-loss grief reinforces withdrawal and delays help-seeking, potentially intensifying distress over time. These findings indicate that strengthening support requires not only individual-level interventions but also social conditions that legitimize pet-loss mourning as a meaningful form of loss experience.

Counseling Support as Both Emotional Care and Psychoeducation

The results also showed that pet-loss counseling frequently involves uncertainty about mourning practices and the lack of accessible information regarding coping and support options. This implies that counseling for pet loss functions not only as emotional care but also as psychoeducational guidance, helping owners interpret grief responses and navigate culturally and personally meaningful ways of mourning. Such a perspective is consistent with grief counseling frameworks that emphasize adjustment through emotional regulation, meaning-making, and continued adaptation to loss (Neimeyer, 2019; Worden, 2018). In practice, counselors may need to support both the emotional dimensions of grief and the cognitive and behavioral aspects of coping, including decision-making related to rituals, memorialization, and daily life reorganization after loss.

The Need for Specialized Counselors, Training, and Supervision

Another major implication concerns the professional challenges faced by counselors. Interviewees emphasized the difficulty of maintaining trustful relationships while managing emotional burden and unclear boundaries. These challenges suggest that the effectiveness and sustainability of pet-loss counseling depend on more than individual goodwill or experience. Evidence-based perspectives in psychotherapy highlight that outcomes are influenced not only by specific techniques but also by relational factors and professional competence, underscoring the value of systematic training and ongoing development (Wampold & Imel, 2015). Therefore, establishing structured educational pathways—such as training curricula, ethical guidelines, and supervision practices—may be essential for strengthening the quality, continuity, and safety of counseling support for pet-loss grief.

Importantly, the present findings support the argument that pet-loss counseling should be treated as a specialized domain. Because pet-loss grief is often socially undervalued, clients may enter counseling with heightened sensitivity to judgment and an urgent need for validation. Counselors who understand the specific characteristics of pet bereavement can provide culturally responsive and ethically appropriate support while clarifying realistic expectations and boundaries. This indicates that the development and placement of pet-loss-specialized counselors is a critical step toward improving support access and reducing disparities in grief care.

Community-Based Learning Opportunities and Social Inclusion

In addition to professional counseling, both owners and counselors pointed to the value of accessible spaces for dialogue and shared learning. Group-based approaches may reduce isolation by fostering mutual recognition and normalization of grief experiences (Yalom & Leszcz, 2005). Community-oriented programs—such as public lectures, peer-support groups, and educational workshops—may offer low-threshold opportunities for individuals who hesitate to seek formal counseling. These approaches may also contribute to broader social awareness and stigma reduction, thereby promoting social inclusion for those affected by pet-loss grief.

Educational Implications and Future Directions

Taken together, the findings suggest that improving pet-loss grief support requires integrated efforts at multiple levels. At the professional level, training and supervision systems are needed to develop competent counselors and sustain ethical practice. At the community level, public education and dialogue opportunities may help create environments in which pet-loss grief can be spoken about safely and respectfully. Future research should further examine how educational frameworks can be institutionalized across disciplines (e.g., social work, psychology, and human–animal interaction studies) and how collaboration between counselors, community organizations, and related services can strengthen pathways to support. Expanding empirical evidence with larger and more diverse samples would also be valuable for clarifying variations in grief experiences and support needs.

Overall, this study contributes to the understanding of pet-loss counseling as an educational and socio-cultural challenge, demonstrating that systematic training, supervision, and community-based learning opportunities are crucial for developing sustainable and compassionate support systems for individuals affected by pet loss.

Conclusion

This study explored the educational aspects of counseling support for individuals experiencing grief after the death of a companion animal by examining interviews with bereaved pet owners and certified pet-loss counselors in Japan. The findings indicate that pet-loss grief can be profound yet socially constrained, often leading to isolation, limited validation, and barriers to help-seeking. In addition, bereaved owners frequently face uncertainty regarding appropriate mourning practices and available resources, suggesting that pet-loss support involves both emotional care and psychoeducational guidance.

Importantly, the study highlights that strengthening pet-loss counseling requires more than individual goodwill and experience. Because counselors may encounter high emotional demands and unclear professional boundaries, systematic training, supervision, and sustainable support structures are essential to ensure the quality and continuity of care. The findings also suggest that community-based learning opportunities and accessible spaces for dialogue can complement formal counseling by reducing isolation and promoting social recognition of pet-loss grief. Overall, this research contributes to the development of inclusive and compassionate support systems by positioning pet-loss counseling as both a psychological and educational challenge.

Limitations

Several limitations should be noted. First, the study sample was relatively small and may not represent the diversity of pet-loss experiences or counseling practices across regions, cultural contexts, or different forms of companion-animal relationships. Second, the findings were based on self-reported interview data, which may be influenced by recall bias, social desirability, and individual differences in narrative expression. Third, while the study captured perspectives from both bereaved owners and counselors, it did not include additional stakeholders such as veterinarians, animal funeral service providers, community organizations, or mental health professionals outside the pet-loss counseling field. Including these perspectives could provide a broader understanding of support pathways and systemic challenges. Future research should expand participant diversity and investigate how training frameworks, supervision models, and community-based programs can be implemented and evaluated in practice.

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Mediation Found in Intercultural Communication Within Multicultural Classes

Etsuko Yamada, Tokyo Polytechnic University, Japan

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Abstract

This study explores the concept of mediation as formulated in the Common European Reference for Languages Companion Volume (CEFR CV) (Council of Europe, 2018, 2020), through an empirical study of interactions in multicultural classes using a lingua franca. The original CEFR (Council of Europe, 2001) has significantly impacted language education in recent decades. A notable difference between the CEFR and the CEFR-CV is the latter's increased focus on non-linguistic competence, such as mediation. This implies that successful communication cannot be achieved through linguistic skills alone. To further explore the concept of mediation, an empirical study was conducted in multicultural classes at a Japanese state university. While these classes are not language teaching classes, they involved Japanese local students and international exchange students working together on PBL (problem-based learning/ project-based learning)-style group projects. Japanese was the language of instruction. Multicultural classes are expected to improve the target language skills and cultural awareness of L2 (second language) students (international students) through authentic interactions with L1 (first language) speakers (Japanese students). However, it is less clear what the Japanese L1 students would develop in the class. The results show that L1 students exercises mediation skills as well as linguistic accommodation. The lingua franca context of multicultural classes provides a meaningful opportunity to practise these skills.

Keywords: CEFR CV, L1 speaker, lingua franca, mediation, multicultural class

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Introduction

This study explores the concept of mediation as formulated in the Common European Reference for Languages Companion Volume (CEFR CV) (Council of Europe, 2018, 2020), through an empirical study of interactions in multicultural classes using a lingua franca. The original CEFR (Council of Europe, 2001) has significantly impacted language education in recent decades. A notable difference between the CEFR and the CEFR CV is the latter's increased focus on non-linguistic competence, such as mediation. This implies that successful communication cannot be achieved through linguistic skills alone. To further explore the concept of mediation, an empirical study was conducted in multicultural classes at a Japanese state university. While these classes are not language teaching classes, they involved Japanese local students and international exchange students working together on PBL (problem-based learning/ project-based learning)-style group projects. Japanese was the language of instruction. Multicultural classes are expected to improve the target language skills and cultural awareness of L2 (second language) students (international students) through authentic interactions with L1 (first language) speakers (Japanese students). However, it is less clear what the Japanese L1 students would develop in the class. The results show that L1 students exercises mediation skills as well as linguistic accommodation. The lingua franca context of multicultural classes provides a meaningful opportunity to practise these skills.

Context

This study focuses on Japanese-medium instruction in multicultural classes at a Japanese university where international and Japanese students study together. The international students who are enrolled in these classes are primarily exchange students participating in Study Abroad programs in Japan for six months to a year. The term, "multicultural class" may not be common in universities in other countries. If a society is already culturally diverse, perhaps such multicultural classes are unnecessary. However, in a country like Japan, where "one nation, one language and one culture" remains generally true despite an increasing foreign population, opportunities to meet foreigners are limited, and multicultural classes can offer students, particularly local ones, the occasions to interact with people from other countries, i.e. a Study Abroad experience without leaving home. Many of these classes are conducted in English, in line with the internationalization policy of higher education to introduce EMI (English-medium instruction). However, quite a few multicultural classes are offered as Japanese-medium instruction classes, for international students who are advanced or better-level second language (L2) Japanese learners. Occasionally, a bilingual mix of English and Japanese multicultural classes are also offered (Yamada, 2023).

The teaching style in multicultural classes typically uses PBL to maximise the interaction between students and with small-group discussions encouraged.

Multicultural classes also tend to offer content-based, non-language teaching courses. A minimum language level is usually required for non-native speakers, but certain language barriers often remain. Managing linguistic accommodations within the classroom can be an issue in such courses (Yamada, 2021). Therefore, topics in multicultural classes require more careful consideration and are more linguistically controlled than usual content-based academic courses. As a part of my own linguistic accommodation approach in teaching such classes, I avoid introducing long reading texts and literature written in authentic Japanese. This is to encourage more smooth oral interactions in the classroom.

Despite the management difficulties, the variety of the students' backgrounds can be considered as an advantage and utilized in multicultural classes. It creates valuable educational opportunities to learn from differences and otherness. The topic addressed in the classes of this study is "education systems and language education". This topic is stimulating because the education systems of different countries reflect cultural diversity. Language learning is a common concern for students, regardless of the language they are studying as a second/foreign language.

Each class consisted of 15 sessions of 90 minutes once per week. Students were divided into small groups of five to six students. During the first seven sessions, lectures were given on educational systems in general, culture and education, the history of higher education and transformations in language teaching. These were followed by discussions. Afterwards, students conducted a group survey project, which included interviewing informants outside the class about their experience of mastering a second language.

Mediation in Discussions and Interactions in Multicultural Classes

Although multicultural classes are non-language teaching classes, they provide an opportunity for L2 learners to practice their language skills. However, interactions in these classes are not limited to L2 learners, but also include native (L1) speakers and take place in a real lingua franca space. It would be interesting to investigate the role of mediation skills in lingua franca communication.

The CEFR (Council of Europe, 2001) has had a significant impact on language education widely over the past few decades. A notable difference between the original CEFR and the revised versions, CEFR-CV (Companion Volume) (Council of Europe, 2020), is the introduction of additional dimensions. One of these is elaboration in mediation, which is positioned as one of the main skills alongside input, output and interaction.

In the initial CEFR, mediation was mainly described as the role of intermediaries, including translating and interpreting.

In both the receptive and productive modes, the written and/or oral activities of mediation make communication possible between persons who are unable, for whatever reason, to communicate with each other directly. Translation or interpretation, a paraphrase, summary or record, provides for a third party a (re)formulation of a source text to which this third party does not have direct access. Mediating language activities – (re)processing an existing text – occupy an important place in the normal linguistic functioning of our societies. (Council of Europe, 2001, p. 14)

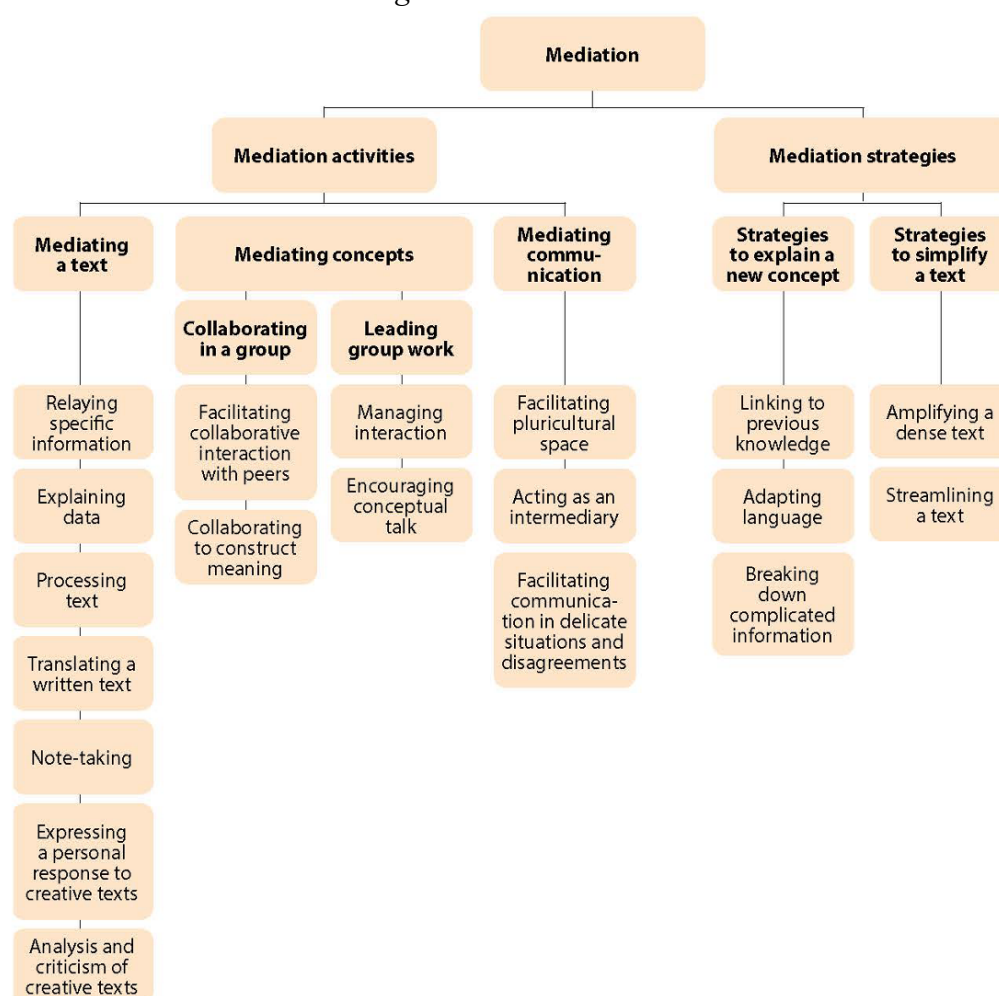
On the other hand, the CEFR CV provides a more detailed overview of mediation concepts, emphasising mediation activities and mediation strategies, and expanding into further sub-skills as shown in Figure 1.

This study explores the relationship between mediation skills and oral interactions in a lingua franca space, involving both L1 and L2 speakers. Therefore, mediation related to a text will not be the focus of this study. "Mediating communication" will not be the focus either, as it functions in informal situations. "Mediating concepts", which have two subskills, seem to be

the most relevant to the context of this study, which mainly involves classrooms discussions. It is described as follows:

‘Mediating concepts’ refers to the process of facilitating access to knowledge and concepts for others, particularly if they may be unable to access this directly on their own. This is a fundamental aspect of parenting, mentoring teaching and training, but also of collaborative learning and work. Mediating concepts involves two complementary aspects: on the one hand constructing and elaborating meaning and on the other hand facilitating and stimulating conditions that are conducive to such conceptual exchange and development. (Council of Europe, 2020, p. 91)

Figure 1
Mediation Activities and Strategies



Note. From Council of Europe, 2020, p. 90

The following research question has been raised in the context of a multicultural class: What indications of mediation can be found in the interactions in multicultural classes?

One particular point of interest is the use of mediation skills by L1 Japanese speakers, who use their L1 but encounter lingua franca communication with which they are usually not familiar.

Empirical Study

This exploratory case study applies a qualitative ethnographic methodology, emphasizing the characteristics of a “natural setting” (Brinkmann & Kvale, 2018; Flick, 2018; Miles et al., 2020). A loose research design (Flick, 2018; Miles et al., 2020) that selected all the related phenomena in naturally occurring data in the field was considered most appropriate for this research. Three types of data were collected: reflection notes collected at the end of each session; an essay about the group project; and semi-structured group interviews performed after the end of the courses. Data triangulation was ensured through the variety of data types. All the data were produced in Japanese and the author translated them into English for this article.

Data collection was conducted at the author’s former place of employment from 2023–2025 and the procedure established by the institution was followed. Permission for data collection was gained from the ethical committee. The students were informed in writing that their products would be used for research purposes. They were also informed of the purpose of the research, confidentiality and anonymity, and that they could withdraw from the study at any time without providing reasons and that this would have no influence on their academic activities.

A total of 29 Japanese and nine international students participated in three Japanese-medium multicultural classes over two academic years (2023–2025). The international students were from Russia, India, China, South Korea, Brazil, Turkey and Australia. The minimum Japanese language requirement for L2 Japanese students (international students) was N2 level or above in the Japanese Language Proficiency Test (CEFR upper B2 level or above).

Cases

This study presents and explains the following three cases according to the patterns of mediation skills. These cases demonstrate the subskills of mediation. More cases appeared, but they were difficult to identify the points clearly. The following cases relate to two subskills of “mediation concepts”: “collaborating in a group” and “leading group work”, as shown in Figure 1. In the following text, *Int'l* represents “international students” and *J* represents “Japanese students”.

Case A: Lack of Spontaneous Involvement

Mediating concepts: collaborating in a group; facilitating collaborative interaction with peers

In our group, it is almost always the international students who start and lead the discussion. Japanese students tend to follow along. (*Int'l*-3-Reflection)

Some international students did not hesitate to speak in Japanese and took charge of group activities. (*J*-5-Reflection)

In group work in other classes, however, Japanese students tend not to speak up, even in Japanese. In general, they do not express their opinions clearly... I wish they would express their opinions more.

In this class, it really depends on the individual. However, I do not want to resort to stereotypes. (Int'l-4-Interview)

As is often pointed out in other multicultural classes, Japanese students tend to be reserved in discussions, although this cannot be generalized to all classes. The “can-do” statements (descriptors) for the A1-B1 levels’ in “collaborating in a group: facilitating collaborative interaction with peers” include “can invite others” and “can collaborate” (Council of Europe, 2020, p. 111).

This can also be related to “turn-taking” in “3.3.2. Interaction Strategies” in the CEFR CV (Council of Europe, 2020, p. 88), if actions such as initiating and intervening are considered the main components. However, the students’ data not only highlights a lack of utterances, but also a lack of participation and management in the discussions.

Case B: L1 Japanese Students’ Linguistic Accommodation for L2 Japanese Speakers

Mediating concepts: leading group work; managing interaction

Yes, on quite a few occasions, Japanese students helped international students express themselves in Japanese. (J-2-Interview)

If there were difficult words, the Japanese students would explain them to us clearly. (Int'l-2-Reflection)

Sometimes I am not sure if our Japanese is understandable to international students. I would like to pay more attention to how I use Japanese. (J-3-Reflection)

In our group, we often checked and explained the meanings of concepts and terms to each other. (J-4-Reflection)

Among the “can-do” statements in “mediating concepts: leading group work: managing interaction” the actions of the L1 students can be considered similar to one of the B1 level descriptors: “can use questions, comments and simple reformulations to maintain the focus of the discussion” (Council of Europe, 2020, p. 111), although they do not match it exactly. The actions of L1 students’ are to use Japanese to try to mediate concepts, but these are different from cross-linguistic mediation, such as interpretation.

Case C: Help With Translation and Interpretation Into Other Languages

Mediating concepts: leading group work; managing interaction

J-1: Is it difficult for international students to exchange text messages in Japanese (to arrange interview schedules outside of the classroom)? I was wondering if I should write messages in English instead of Japanese. (Because int'l-1 student sometimes did not answer Japanese students’ written messages.)

Int'l-1: Yes, actually, I am not good at writing messages in Japanese.

(.....)

J-1: I often felt that international students were very careful when selecting Japanese words. When it took them too long to come up with the right words, I wondered if I should ask them to speak in English so that we could translate it into Japanese for them. I wonder if that would help them. (...) I got the impression that they wanted to finish the Japanese sentence themselves so that they would not be helped. In fact, they rarely asked Japanese students for help. There was no opportunity for us to interject either. (J-1/ Int'l-1-Interview)

This L1 Japanese student immediately realized that the L2 student was having difficulty producing Japanese output. She considered helping him by interpreting into English, his first language, but decided against it as she wanted to respect his desire to express himself in Japanese.

According to the CEFR CV, this could be considered “mediating concepts: leading group work: managing interaction”. However, the action of cross-linguistic interpretation that the L1 Japanese student tried to offer would be better categorized as building on a plurilingual repertoire in plurilingual and pluricultural competence, which is outside the “mediation” category.

Conclusion and Future Agenda

Although the CEFR CV does not assume mediation competence in L1 speakers, this study also revealed the value of multicultural classes for L1 Japanese students. These classes certainly encourage them to engage in mediation, which they would not experience in other classes or foreign language classes. Although it is a non-language class, L1 students will certainly be able to develop important skills for living in an international society. These classes will be suitable for the general education of the first-year students.

Although the CEFR CV descriptors are not intended for use as rubrics, they provide a kind of guidepost. However, as Liddicoat and Derivry-Plard (2021) point out, mediation is a complex process, whereas the descriptors are oversimplified. It will be difficult to consider mediation as a gradable skill. Unlike linguistic skills, progress in mediation does not follow a gradual linear path from A1 to C2. Therefore, the subskills involved in mediation will need to be examined more closely.

This exploratory, ethnographic study investigated what emerged naturally from the field. This preliminary analysis shows that more thorough and in-depth research is needed to determine the most effective educational interventions for developing students' mediation skills.

Acknowledgement

I would like to express my gratitude to the students who participated in these multicultural classes.

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Contact email: etsukoyamada91@gmail.com

From Text to Visual Story: Enhancing STEM Students' English Writing

Makoto Shishido, Tokyo Denki University, Japan

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Abstract

This paper reports on a classroom study that introduced Adobe Express and its generative AI engine, Firefly, into an English as a foreign language class for STEM students in Japan. Many STEM learners encounter difficulties in writing, not only because of limited vocabulary but also due to hesitation in expressing personal ideas and little experience with creative communication. To respond to these challenges, I implemented a project-based instructional model combining writing with visual design. Students followed four steps: (1) composing a short essay, (2) revising tone and clarity with support from AI tools, (3) generating images that reflected their text, and (4) creating slides or posters using Adobe Express. By combining words and visuals, students were able to engage in more meaningful self-expression. Their written work demonstrated stronger narrative structure and improved audience awareness. Survey feedback indicated that AI-supported visual storytelling increased motivation and made revision feel more purposeful. While some students required initial guidance in using the tools, most adapted quickly and appreciated the multimodal format. The results suggest that generative AI, when used thoughtfully, can act as a supportive partner rather than a substitute. Adobe Firefly and Express encouraged students to rethink how text and images interact to convey meaning, helping them to move away from rigid prose toward more creative and communicative writing. These findings highlight the pedagogical potential of generative AI for supporting expression, creativity, and engagement among STEM learners.

Keywords: generative AI, AI-assisted writing, multimodal composition, project-based learning, STEM EFL learners

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Introduction

In today's global and digitally connected world, English proficiency has become an essential skill for STEM students. While their technical fields demand logical precision, many of these students have little experience with expressive and creative communication. As a result, they may write essays that are grammatically correct but lack fluency, flow, or a personal voice. In Japan, traditional English writing instruction has frequently placed a strong emphasis on accuracy and structure, leaving limited space for students to experiment with ideas or narrative style. This gap creates a real challenge: learners may possess strong technical knowledge but still struggle to convey their ideas effectively to a broader audience.

Generative AI tools such as Adobe Firefly and Adobe Express offer new ways to address this challenge. By combining text and visual elements, they allow students to transform abstract concepts into more engaging forms of communication. These tools can lower the barrier to creative expression, making the writing process feel less intimidating and more interactive. For instance, Firefly's text-to-image feature enables students to visualize their ideas, while Express provides accessible design functions that help them build professional-looking posters or slides.

As an instructor, I was interested in whether integrating these tools into writing assignments could help STEM students improve both confidence and creativity. Could they learn to view English not just as a technical requirement but also as a medium for storytelling and expression? This paper describes how I incorporated Firefly and Express into an English course and examines their effects on student writing, motivation, and engagement.

Theoretical Framework

The design of this project was informed by several well-established educational theories and frameworks. Each of them highlights a different dimension of how students learn, and together they provide the rationale for bringing generative AI into writing instruction.

First, constructivism (Papert, 1980) emphasizes that learners build knowledge most effectively when they actively create and shape their own learning materials. This principle guided the idea of having students generate not only text but also images and slides.

Second, Kolb's Experiential Learning Cycle (1984) stresses the importance of learning through action, reflection, and application. The four-step process used in this study—writing, revising, visualizing, and presenting—closely mirrors this cycle.

Third, Multimedia Learning Theory (Fiorella & Mayer, 2015) suggests that combining words with visuals can lead to deeper understanding and better retention. Asking students to generate images with Firefly was one way to put this principle into practice.

Fourth, Bloom's Taxonomy (Anderson & Krathwohl, 2001) provides a framework for moving from lower-order thinking skills, such as remembering and understanding, toward higher-order skills like analysis and creation. The project encouraged students to progress along this continuum by revising and redesigning their work.

Finally, the UNESCO Digital Literacy Framework (2018) underscores the importance of creativity, problem-solving, communication, and adaptability—skills that extend beyond the

classroom into students' future careers. Integrating generative AI was one way to align English writing instruction with these 21st-century competencies.

Taken together, these perspectives justify the use of multimodal, AI-enhanced writing tasks that ask students not only to compose text but also to experiment, reflect, and communicate in richer, more creative ways.

Methodology

Participants

The study was conducted with undergraduate STEM majors enrolled in an English language course at Tokyo Denki University. The participants represented a range of English proficiency levels, from false-beginners to lower-intermediate, and the majority had little or no prior experience using generative AI tools. This diversity allowed us to observe how students with different language backgrounds adapted to the integration of Firefly and Express in their writing tasks.

Procedure

To explore how generative AI could support creative writing, I designed a Four-Step Creative Learning Model that was implemented over the course of one semester.

Essay Writing

Students began by writing short essays on familiar and personally meaningful topics. Examples included dream trips, global cities, aspects of cultural heritage, and contemporary themes such as Society 5.0. The aim was to encourage authentic expression while keeping the topics accessible.

Tone Refinement With AI

After completing their drafts, students used AI tools—Adobe Firefly, Adobe Express, and ELST—to revise tone, improve clarity, and address grammatical issues. The process was not about producing a “perfect” text but about helping students notice alternatives and refine their ideas.

Image Generation

Next, students created visual representations of their essays using Firefly's text-to-image prompts. For example, one student who wrote about Paris generated an image of the Eiffel Tower illuminated at night, which complemented the narrative in the essay.

Slide/Poster Creation

Finally, students combined their written work and AI-generated visuals into slides or posters using Adobe Express. The tool's simple design features enabled them to produce structured, visually appealing presentations that could effectively communicate their ideas to an audience. This cycle not only mirrored Kolb's experiential learning model but also encouraged students to move iteratively between writing, reflection, and creative redesign.

Data Collection

To capture a full picture of student learning and engagement, data were gathered from several sources. First, student essays were collected in both their original and revised forms. This allowed for a direct comparison of how tone, structure, and clarity changed after students used the AI tools. In addition, the images generated with Adobe Firefly were reviewed to see how students translated their written ideas into visual form and how these visuals complemented the narratives.

The final products—slides and posters created in Adobe Express—were also analyzed, focusing on how effectively students integrated text and visuals into coherent multimodal presentations. Alongside these artifacts, a post-course survey (including Likert-scale and open-ended items) provided insights into students' perceptions of the process. Finally, my classroom observations served as an additional layer of data, offering context about how students engaged with the tools during lessons.

During the review, I also noticed that a small number of essays showed signs of being far beyond the writer's usual ability. In one case, vocabulary range and syntactic complexity were inconsistent with the student's previous work, raising the possibility of unacknowledged AI assistance. Such instances underline the importance of setting clear guidelines for the ethical use of generative AI in academic writing, as well as incorporating in-class writing activities to ensure authenticity.

It is worth noting that the essay shown in Figure 1 appears to exceed the typical writing proficiency of the student who submitted it. The vocabulary range, sentence structure, and overall style are noticeably different from the student's earlier work and from the general level of the class. This discrepancy suggests that the text may have been generated—or at least heavily influenced—by an AI tool, without clear acknowledgment.

Such cases underline the importance of establishing transparent guidelines for the ethical use of generative AI in academic settings. They also highlight the need to design tasks and in-class writing activities that allow instructors to better confirm the authenticity of student work, while still encouraging students to explore the benefits of new technologies responsibly.

Figure 1

Example Student Essay 1

I would like to go to Italy to visit tasteful and beautiful architecture. Italy is a country of beauty and affluence where history, culture, gastronomy, and nature are united. For example, popular Italian foods such as pizza, pasta, risotto, cheese, wine and raw ham can be eaten everywhere. The Vatican Museum of Art in Vatican City, the world's smallest independent country, offers a view of some of the world's best works of art, including the works of Leonardo da Vinci, Michelangelo and Raphaelo, the three greatest Renaissance masters. In addition, we can see various architectures from ancient Rome to modern times, including Milan Cathedral in Milan, San Marco Temple in Venice, and Colosseum and Pantheon Temple in Rome. And I thought about the itinerary where I could visit tasteful and beautiful architecture in Italy. On the first day, I am thinking of visiting Venice. I would like to see the magnificent Gothic Ducal Palace. And I would like to ride a gondola, a traditional rowing boat, and see the beautiful streets. On the second day, I will visit Rome, a treasure trove of world heritage. There, I would like to go to the Colosseum, a circular stadium built in ancient Rome, the Pantheon Temple, which features a front entrance consisting of eight huge pillars, and Spain Square, which has steps

designed like waves. And I love Italian food, so I would like to eat pizza and pasta to my heart's content.

Figures 2, 3, and 4 show examples of student essays that were written independently but highlight some of the common challenges faced by learners. The writing tends to rely on short and simple sentences, vocabulary is limited, and grammatical errors appear frequently. Overall, the texts do not fully meet the expectations for the assignment in terms of linguistic accuracy or communicative depth.

Figure 2

Example Student Essay 2

I want to go to the UAE. I especially want to go to Dubai and Abu Dhabi. The Burj Khalifa is located in Dubai. The Burj Khalifa is the tallest tower in the world. I would like to see the view of Dubai from the observatory. In Abu Dhabi, I would like to visit Ferrari World. This is a roller coaster in the shape of an F1 car.

Figure 3

Example Student Essay 3

My first trip will be Dubai. I will visit the Burj Khalifa. I will enjoy the view from the top of the world's tallest building. After , I will shopping Dubai Mall, and exploring the famous Dubai Aquarium. I want to buy a souveir there. I will enjoy a watar performance at the Dubai Fountain at night.

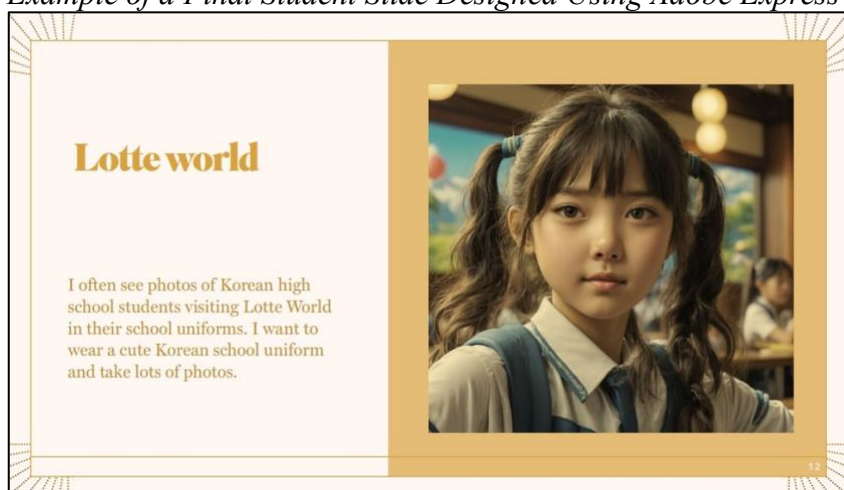
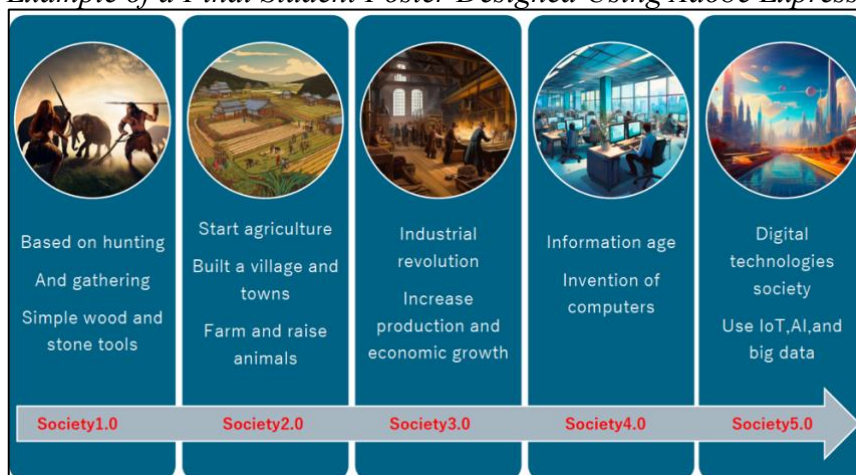
Figure 4

Example Student Essay 4

I'd like to go to Cairo. Especially, I'd like to go to Amr Ibn al-As Mosque because it is so seminary, Arabian Coast in Tokyo Disney Sea. I like its mood. It is beautiful at all times, but especially beautiful at night.

To address these issues, the course design incorporated creative writing activities that combined student-produced text with AI-generated visuals. This multimodal approach aimed to spark richer vocabulary use, encourage more detailed descriptions, and support greater engagement with the writing process by allowing students to visualize and expand their ideas.

As seen in Figures 1 through 4, some essays suggested the possibility of AI-assisted plagiarism, while others clearly reflected students' limited English proficiency. However, when students were encouraged to pair their writing with images, the results showed a marked improvement in both content and presentation. The contrast becomes especially evident in later examples (Figures 5 and 6), where the integration of text and visuals led to more coherent, expressive, and engaging outputs.

Figure 5*Example of a Final Student Slide Designed Using Adobe Express***Figure 6***Example of a Final Student Poster Designed Using Adobe Express*

These examples illustrate how students' writing developed when paired with visual expression. The essays remained authentic student work, but by adding AI-generated images, learners were encouraged to treat their writing as a creative project rather than as a purely linguistic exercise. The act of visualizing their ideas helped them refine vocabulary, include more descriptive detail, and experiment with sentence variety, while also strengthening the connection between text and visuals.

Figure 5 shows a final slide created in Adobe Express, and Figure 6 presents a poster that students designed as part of their project. Both tasks required them to integrate written and visual elements into a single, coherent product, which in turn pushed them to think about tone, clarity, and audience engagement.

What is most notable is that this process addressed earlier issues such as plagiarism concerns or overly simplistic writing. Instead, students were motivated to produce more original and higher-quality work. The integration of Firefly and Express effectively transformed the writing task into a design-oriented process—one that supported grammatical accuracy, narrative structure, and creative communication skills in a way that traditional essay writing alone often could not achieve.

Findings

Writing Quality

Students' revised essays showed clearer organization and more coherent narratives after the integration of AI tools. Although minor grammar issues were still present, the overall tone improved, and the texts flowed more naturally. The support provided by Firefly and Express allowed students to concentrate more on developing their ideas rather than being constrained by sentence-level errors.

Creativity and Expression

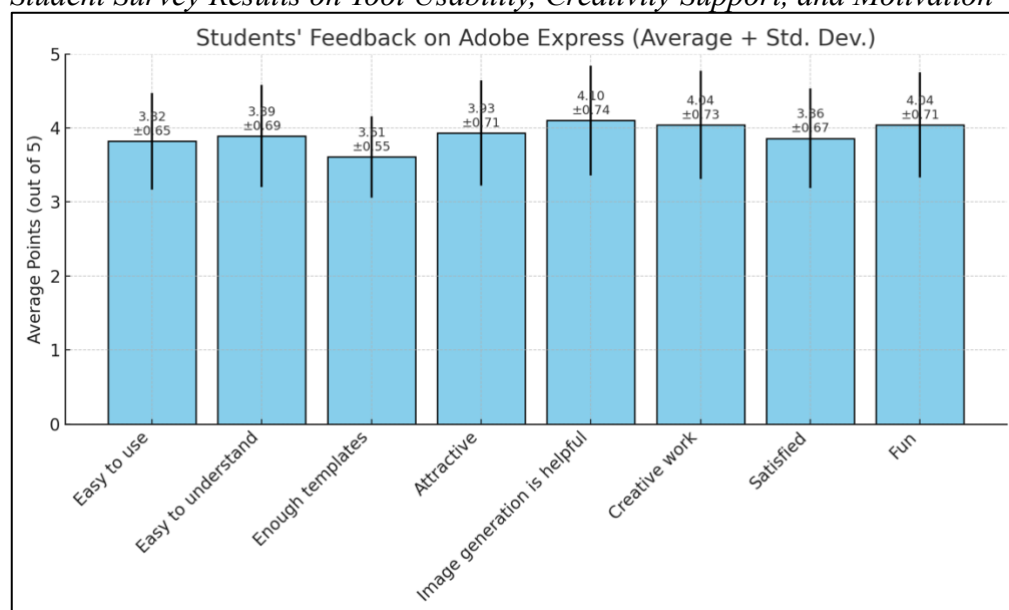
The addition of visual storytelling pushed students to move beyond formulaic structures. Several reported that generating images led them to rethink what they wanted to say and how best to say it. The process of pairing images with text often prompted students to expand descriptions and refine their narratives, demonstrating a deeper engagement with the writing task.

Survey Findings

To better understand students' perceptions, a post-course survey was administered using both Likert-scale items and open-ended questions, supplemented by instructor observations. The results, illustrated in Figure 7, indicate consistently positive evaluations across all categories. Ease of use received a relatively high rating ($M = 3.69$), showing that most students found the tools accessible. Perceived usefulness for English learning scored even higher ($M = 3.98$), and support for creativity achieved the top score ($M = 4.00$), highlighting the tools' role in fostering expressive outputs. Slide design attractiveness also received a favorable score ($M = 3.88$), suggesting that Express contributed to more polished and engaging presentations.

Figure 7

Student Survey Results on Tool Usability, Creativity Support, and Motivation



Beyond the quantitative results, many students reported that the activities increased their motivation to write in English, confirming the value of integrating multimodal tasks.

Student Feedback (Selected)

Open-ended responses reinforced these findings. A number of students indicated that they intended to use Adobe Express in future presentations, recognizing its practical value. Others noted that the stylish templates enhanced the quality of their slides, while some explained that Firefly-generated images helped them refine their essay ideas and provided inspiration for revisions.

“I plan to use Adobe Express in future presentations.”

“Stylish templates made my slides more appealing.”

“Firefly images helped me refine my essay ideas.”

Discussion

The findings suggest that generative AI tools can significantly enhance both the cognitive and affective aspects of language learning. By combining written and visual elements, students were encouraged to approach writing as a form of storytelling, which not only boosted creativity but also increased engagement and motivation. Importantly, the AI tools acted less as replacements and more as creative partners, encouraging students to iterate on their work and reflect on their choices—key elements of constructivist learning.

At the same time, the project highlighted the need for structured onboarding. A few students initially felt uncertain when using the tools, and this limited their creative output. With clearer guidance and scaffolding, however, these obstacles were reduced, underscoring the importance of careful implementation in technology-enhanced classrooms.

Future Directions

Building on the encouraging outcomes of this project, several directions for further research and practice emerge. First, longitudinal studies would allow us to examine how multimodal, AI-assisted instruction influences students’ writing and presentation skills over an extended period. Second, we plan to apply the Four-Step Creative Learning Model to more specialized STEM writing tasks, such as abstracts, technical reports, or research summaries, to test whether this approach can enhance not only general English expression but also discipline-specific communication.

Another promising avenue is to integrate Adobe’s collaborative functions for peer review, enabling students to exchange feedback on both text and design. Such activities could deepen engagement and foster critical reflection, while also building teamwork and communication skills. Finally, offering structured training in AI prompt design may help students create more precise image-text combinations, further improving the quality of their multimodal projects.

Extended Pedagogical Reflections

Our observations also highlight broader pedagogical implications. The integration of Adobe Firefly and Express shifted the classroom dynamic from a teacher-centered model toward student-centered creativity. The Four-Step Creative Learning Model offered a supportive structure for beginners, while giving more advanced students space to experiment with both language and design.

Initially, some students were hesitant to use AI-generated content, unfamiliar with prompt-based systems. However, their confidence quickly grew as they experienced the immediacy of generating high-quality images and adapting them to fit their narratives. This aligns with Papert's idea of "learning through making," where creative production leads to deeper understanding.

Collaboration naturally emerged during the design stages. Students exchanged ideas about visual styles, prompts, and layouts—often in English—turning the design process into an authentic communicative task. The interplay between text and visuals also reshaped the revision process: students no longer saw revision as mere error correction but as part of a creative cycle of refinement. This reciprocal adjustment between writing and images enriched both forms of expression.

For instructors, multimodal outputs provided a fuller picture of students' learning, revealing depth that might not appear in text alone. Peer review sessions also became more engaging, as students could comment on both content and design. Overall, the project suggests that generative AI not only enhances language learning but also builds transferable skills such as adaptability, problem-solving, collaboration, and digital creativity—skills that are crucial in STEM fields and align closely with UNESCO's Digital Literacy Framework.

Conclusion

In sum, integrating Adobe Firefly and Adobe Express into English writing instruction created a new learning environment in which STEM students combined verbal and visual modes of expression. The approach strengthened narrative coherence, creativity, and motivation while promoting broader communicative and digital skills.

Looking ahead, the incorporation of peer collaboration, prompt-design training, and STEM-specific writing tasks could further expand the potential of this framework. As generative AI becomes increasingly integrated into education, its role as a creative partner rather than a simple tool will likely grow, supporting students in developing not only linguistic proficiency but also the broader competencies needed for success in global STEM communication.

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How Informal Digital Engagement Shapes Vocabulary Growth Among Saudi EFL Learners

Mohammed Hassan Alshaikhi, University of Tabuk, Saudi Arabia

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Abstract

While casual digital engagement, such as browsing social media, streaming videos, and gaming, has become an integral part of Saudi university students' daily lives, its role in English vocabulary development remains underexplored. This study investigates how learners' motivations for engaging in these digital activities and the strategies they employ during or after such experiences contribute to different dimensions of vocabulary knowledge. The research was conducted at one public Saudi university with 93 male EFL undergraduates who completed all study phases. Participants were randomly assigned to a treatment group, which received micro-prompts to save and use new words in sentences, or a control group. Data sources included vocabulary breadth and depth tests administered at three time points, a digital habits survey, experience-sampling prompts, and passive usage logs. Analyses using structural equation modeling and mixed ANOVA revealed that learners' depth of processing, particularly attention to form–meaning relationships and example generation, significantly predicted both short-term gains and retention. Effects differed between receptive and productive vocabulary knowledge, with deep processing emerging as the strongest predictor of sustained development.

Keywords: informal digital learning, vocabulary growth, Saudi EFL learners, self-regulated learning, processing depth

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Introduction

Vocabulary learning remains central to second language acquisition (SLA). It underpins comprehension, communication, and coherent discourse. Learners with limited lexical knowledge often struggle to express meaning, even when their grammar is adequate. Traditionally, vocabulary development has relied on structured classroom instruction. However, digital technologies now extend learning beyond the classroom by providing authentic, spontaneous, and multimodal exposure, particularly for English as a Foreign Language (EFL) learners.

In Saudi Arabia, university students operate daily within hybrid Arabic–English digital spaces. They browse social media, watch subtitled videos, play online games, and communicate through mixed linguistic codes. These activities immerse them in authentic English use. Yet exposure alone does not guarantee learning. While digital environments provide abundant input, they also encourage passive scrolling and shallow processing. Learners may repeatedly encounter words without integrating them meaningfully (Godwin-Jones, 2020; Peters, 2019). In this study, informal digital learning of English (IDLE) refers to incidental, self-directed engagement with English through everyday digital activities outside formal instruction.

A key distinction in vocabulary research is between breadth (number of words known) and depth (quality of knowledge about those words). Breadth develops largely through frequency of exposure, whereas depth requires deliberate engagement with meaning, form, and use (Nation, 2001; Schmitt, 2014). Depth supports collocational knowledge, grammatical awareness, and subtle meaning distinctions. Digital environments often prioritize quantity over quality. The central issue, therefore, is not whether digital engagement supports vocabulary growth, but how and under what cognitive and motivational conditions it does so.

Gaps of the Study

Despite growing interest in IDLE, important gaps remain. Much existing research relies on self-report surveys or correlational designs that limit causal interpretation. Digital engagement is often treated as a single construct, without examining the cognitive and affective processes that shape learning outcomes. In the Saudi context, empirical research remains limited. Few studies have explored how digital routines interact with strategy use, motivation, and processing depth to influence vocabulary development.

To address these gaps, this study examines whether informal digital engagement, enhanced through micro-prompts, leads to measurable gains in vocabulary depth among Saudi EFL learners. Micro-prompts are brief cues that encourage deeper processing during authentic digital activity. For example, learners may be asked to predict meanings, notice collocations, or paraphrase captions. These prompts aim to promote reflection without interrupting natural engagement.

The study combines ecological validity with experimental control by embedding structured micro-interventions within authentic digital routines and measuring development over time. This design allows closer examination of how informal digital engagement contributes to vocabulary learning.

Aims of the Study and Research Questions

This study aims to:

- Examine whether integrating micro-prompts into informal digital routines enhances vocabulary depth.
- Investigate whether depth of processing predicts vocabulary growth across time.
- Explore the cognitive, motivational, and contextual mechanisms learners associate with vocabulary learning beyond the classroom.

Accordingly, the study addresses the following research questions:

- RQ1: To what extent does integrating micro-prompts into informal digital routines enhance vocabulary depth among Saudi EFL undergraduates over time?
- RQ2: To what extent does depth of processing predict longitudinal vocabulary growth across multiple assessment points?
- RQ3: What cognitive, motivational, and contextual mechanisms do learners identify as contributing to vocabulary learning in informal digital environments?

Significance and Contribution

This study contributes to SLA research by linking ecological authenticity with experimental rigor through a mixed-methods design. It moves beyond measuring exposure frequency to examine the quality and intentionality of engagement. Using structural equation modeling (SEM) alongside qualitative analysis, it models directional relationships while capturing learners' lived experiences. In doing so, it responds to calls for dynamic and context-sensitive research in underrepresented EFL contexts such as Saudi Arabia.

Theoretical Frameworks

To explain how digital routines support vocabulary development, this study draws on four complementary frameworks. Together, they address cognitive, motivational, behavioral, and social dimensions of language learning.

Depth of Processing

Based on Craik and Lockhart (1972), vocabulary retention depends more on how words are processed than on how often they are encountered. Deeper processing occurs when learners create examples, notice collocations, and connect new words to prior knowledge. In contrast, simple recognition leads to weaker retention. The micro-prompts in this study were designed to encourage such elaboration. They asked learners to link word form, meaning, and use during everyday digital activities. Previous research (e.g., Peters et al., 2016) shows that tasks requiring semantic engagement promote vocabulary depth more effectively than passive exposure. This framework therefore positions strategic cognitive effort as central to durable lexical growth.

Self-Regulated Learning

Drawing on Zimmerman (2000), informal digital vocabulary learning is viewed as a self-directed process. Without teacher supervision, learners must set goals, monitor progress, and reflect on their learning. Simply encountering words online does not guarantee retention; learners need to notice, record, and revisit vocabulary intentionally. The micro-prompts

functioned as metacognitive scaffolds. They encouraged learners to pause, think, and evaluate their vocabulary use. In this way, the intervention aimed to shift learners from passive digital consumption to more regulated and strategic engagement.

L2 Motivational Self System

Dörnyei's (2009) L2 Motivational Self System explains how learners' future self-images shape engagement. Motivation is not fixed; it changes depending on how learning experiences connect to learners' goals and identities. Digital environments that promote enjoyment, relevance, and autonomy may activate learners' Ideal L2 Selves (Al-Hoorie, 2018; Dörnyei, 2009). In this study, micro-prompts encouraged learners to reflect on progress and align digital practices with long-term language goals. By strengthening the quality of the learning experience, the intervention sought to sustain motivation in informal contexts.

Sociocultural Theory

From a sociocultural perspective (Vygotsky, 1978), vocabulary learning is socially mediated. Interaction with peers, digital tools, and cultural practices shapes cognitive development. Messaging apps and shared platforms are not neutral spaces; they mediate meaning-making and collaboration (Lantolf & Thorne, 2006). Learners often negotiate meaning, share examples, and evaluate usage together. These exchanges create opportunities for repeated exposure and contextualized learning. Vocabulary development therefore occurs within socially embedded digital practices rather than in isolation.

An Integrated Model

Rather than treating these frameworks separately, this study adopts an integrated perspective. Depth of processing explains how words are elaborated. Self-regulation explains how learning is managed. Motivation explains why learners sustain engagement. Sociocultural mediation explains where and with whom learning occurs. Together, these dimensions capture vocabulary development as a dynamic and ecologically situated process. As shown in Table 1, this integrated model provides a foundation for examining how micro-prompt-supported digital practices can transform everyday online engagement into sustained vocabulary growth.

Table 1

Theoretical Frameworks Underpinning the Integrated Model

Theoretical Framework	Core Mechanism	Linked Research Question
Depth of Processing Hypothesis	Semantic elaboration strengthens lexical retention	RQ1: Do micro-prompts enhance vocabulary depth?
Self-Regulated Learning (SRL)	Goal-setting, monitoring, and reflection structure engagement	RQ2: Does processing depth predict vocabulary growth?
L2 Motivational Self System (L2MSS)	Ideal L2 Self and motivational alignment sustain effort	RQ3a: What motivational factors shape engagement?
Sociocultural Theory (SCT)	Social mediation and peer interaction contextualize learning	RQ3b: What contextual factors contribute?

Literature Review

Vocabulary Development in Informal Digital Contexts

Vocabulary acquisition has long been recognized as central to second language proficiency (Nation, 2001; Schmitt, 2014). However, lexical learning increasingly extends beyond formal classrooms into informal digital environments. Research on informal digital learning of English (IDLE) examines how engagement with social media, streaming, messaging, and other online activities supports incidental vocabulary growth. Despite this expansion, findings remain mixed and fragmented. Several studies (e.g., Lee & Dressman, 2018; Peters, 2019; Sockett & Toffoli, 2021) suggest that digital exposure promotes lexical development by providing authentic, contextualized input. Yet exposure alone does not guarantee learning. Online engagement often lacks intentional focus on form–meaning connections. Learners may scroll through multimodal content or watch subtitled videos without processing words deeply. This gap between digital potential and cognitive engagement raises questions about how vocabulary is actually processed during informal use.

Depth of Processing and the Role of Strategy Use

Research grounded in the Depth of Processing framework (Craik & Lockhart, 1972) shows that retention improves when learners engage in elaborative tasks such as generating sentences, linking words to prior knowledge, and noticing collocations. However, many digital habits, especially multitasking or passive browsing, do not naturally promote such elaboration. Although digital platforms offer rich lexical input (Godwin-Jones, 2020; Kim & Gilman, 2008), learners frequently engage with it superficially. To address this issue, scholars have explored strategy-based interventions embedded within digital routines (Reinders & White, 2016; Rosell-Aguilar, 2020). These include prompts, reminders, and reflective tasks that encourage deeper engagement. While findings suggest that lightweight interventions can nudge learners toward elaboration, most studies remain exploratory and provide limited causal evidence.

Motivation, Identity, and Self-Regulation

Beyond cognitive processing, recent research highlights the role of motivation and emotion in digital vocabulary learning. Drawing on the L2 Motivational Self System (Dörnyei, 2009), Liu et al. (2023) argue that learners with vivid Ideal L2 Selves are more likely to transform casual digital habits into meaningful learning experiences. Similarly, Ziegler et al. (2021) report that enjoyment and emotional investment are linked to stronger lexical outcomes. These findings suggest that affective engagement may reinforce deeper processing. Self-regulated learning (SRL) also plays a mediating role (Lai & Gu, 2011; Rezai et al., 2024). Learners differ not only in exposure but in their ability to monitor, evaluate, and adjust their learning strategies. However, as Lai (2021) notes, many learners lack the metacognitive awareness needed to regulate learning in informal digital contexts. This reinforces the need for scaffolded interventions that build strategic behavior.

Methodological Limitations in IDLE Research

Despite conceptual advances, IDLE research remains methodologically limited. Many studies rely on cross-sectional self-report surveys (Lee, 2017; Liu et al., 2023; Smith, 2011), restricting causal interpretation and failing to capture dynamic engagement patterns.

Retrospective diaries and questionnaires are also vulnerable to recall bias. Experimental and longitudinal designs integrating behavioral traces and standardized lexical assessment remain relatively rare, particularly in non-Western contexts such as Saudi Arabia. Furthermore, contextual moderators, including cultural norms, institutional structures, and gendered access to digital resources, are often underexplored. This limits the transferability of findings across learning environments.

Addressing the Gaps: Contributions of the Current Study

The present study seeks to address these limitations through four main contributions:

- **Clear Operationalization:** It distinguishes between vocabulary breadth and depth using validated testing instruments, moving beyond vague notions of “vocabulary knowledge.”
- **Ecologically Valid Mixed Methods:** The study embeds micro-prompts into real digital routines and triangulates outcomes using lexical assessments, digital logs, and learner reflections.
- **Causal Modelling:** It employs cross-lagged structural equation modelling (SEM) to examine the dynamic relationship between engagement, depth of processing, and lexical outcomes across time.
- **Contextual Relevance:** It focuses on Saudi EFL learners, a demographic underrepresented in IDLE research, while capturing sociocultural factors that shape vocabulary development.

By integrating experimental control with naturalistic design, the study offers a nuanced and context-sensitive understanding of informal digital routines. When these routines are scaffolded with strategic micro-interventions, they can promote deeper vocabulary learning.

Methodology

A well-designed methodology ensures that research questions are addressed with clarity and rigor. The present study employed a convergent mixed-methods design (Creswell & Plano Clark, 2018), a robust approach for examining complex phenomena in applied linguistics. This design enabled simultaneous analysis of measurable vocabulary gains and learners’ lived experiences. Quantitative measures assessed lexical development, while qualitative tools explored processing depth, strategy use, and perceptions. The approach combined ecological validity with experimental structure, allowing investigation of causal pathways within authentic digital contexts.

Participants

The sample included 93 Saudi male EFL undergraduates from a public university. All were English majors aged 18–24 who reported regular engagement with English digital media. Data collection was conducted at a male-only campus, consistent with Saudi gender-segregated educational structures. Although initial plans included female participants, access restrictions limited recruitment to male students. All participants met eligibility criteria (intermediate to upper-intermediate proficiency and active digital use) and completed all study phases. The sample size provided adequate statistical power for mixed ANOVA and SEM analyses. While homogeneous in gender and institutional context, this consistency reduced extraneous variation in digital engagement patterns, strengthening internal validity but limiting generalizability.

Instruments

A multi-instrument strategy was adopted to minimise reliance on a single method and to enable cross-validation:

- Digital Habits Questionnaire (DHQ): Measured frequency, strategic behaviors, and affective engagement.
- Vocabulary Size Test (VST) and Word Associates Test (WAT): Two of the most widely used tools for assessing breadth and depth of lexical knowledge (Nation, 2001; Read, 2004).
- Learner Reflective Notes and Written Comments: Captured strategy use, motivation, and engagement without intrusive monitoring.
- Experience-Sampling Method (ESM): Recorded real-time engagement patterns. This variety of instruments ensured that the strengths of one method compensated for the limitations of another. Standardised tests provided objectivity and ESM enhanced ecological validity.

This combination minimized single-method bias and strengthened construct validity.

Procedure

Data collection unfolded in sequential stages:

- Baseline Testing: VST and WAT administered during Week 0 to establish a benchmark.
- Survey Administration: DHQ distributed online to capture initial patterns of digital habits.
- Randomisation: Participants randomly assigned to a treatment group (receiving micro-prompts to save and sentence new words) or a control group (no prompts).
- Field Phase: Over 14 days, ESM prompts were completed three times daily; optional passive logs were also collected.
- Post-Testing: Vocabulary tests repeated in Week 2 and Week 4 (delayed retention).
- Written Reflections: A purposive subsample of 20 learners representing different proficiency bands submitted short written comments on their digital vocabulary learning experiences. These qualitative reflections were used to contextualize quantitative findings and to support methodological triangulation.

Micro-prompt Design and Delivery

Micro-prompts were delivered manually via widely used messaging platforms (e.g., WhatsApp) to integrate smoothly into learners' digital routines. Participants in the treatment group received two to three prompts daily during the 14-day field phase. Prompts were brief, platform-agnostic, and non-intrusive. Learners were encouraged, but not required, to save unfamiliar words, generate example sentences, or reflect on usage. The prompts targeted distinct processing phases: noticing, semantic elaboration, and metacognitive reflection (see Table 2). Each prompt aligned with principles from the Depth of Processing and Self-Regulated Learning frameworks, functioning as cognitive nudges rather than formal tasks to preserve ecological validity.

Table 2
Micro-prompt Types and Intended Functions

Prompt Type	Timing	Example	Intended Cognitive Process
Noticing Prompt	During video/text viewing	“Pause and predict the meaning of this word”	Attention to form—meaning
Elaboration Prompt	After encounter	“Use this word in a sentence”	Semantic elaboration
Reflection Prompt	End of day	“Which new words did you remember today?”	Metacognitive monitoring

Data Analysis

Quantitative Strand

Descriptive statistics (means, SDs, skewness, kurtosis) were calculated for all measures. Independent t-tests confirmed baseline equivalence between groups. A mixed ANOVA examined vocabulary gains across groups and time points (pre, post, delayed). Cross-lagged panel SEM tested directionality of effects, assessing whether processing depth (from ESM) predicted subsequent vocabulary outcomes. Reliability checks showed Cronbach’s alpha values for DHQ subscales ranging from .78 to .86, confirming internal consistency.

Qualitative Strand

Written learner comments and open-ended ESM responses were coded thematically using a systematic manual coding procedure. Deductive categories (depth, regulation, motivation, and context) were complemented by inductive themes emerging from learner accounts. To enhance analytic rigor, a subset of the data was independently coded by a second rater, yielding an inter-rater agreement of 87%, exceeding the 80% threshold commonly accepted in applied linguistics research. Findings from both strands were integrated during interpretation. Triangulation across surveys, tests, and logs strengthened construct validity and yielded a multi-layered account of learner engagement.

Reliability and Validity

Multiple safeguards ensured trustworthiness. Triangulation across tests, surveys, ESM, and reflections reduced bias. Statistical controls addressed false discovery risks. Inter-rater agreement and member validation reinforced qualitative credibility.

Ethical Considerations

Participants provided informed consent and could withdraw at any time. Passive logging required separate opt-in approval. All data were anonymized, and incentives were provided through course credit and digital vouchers. In sum, the mixed-methods design balanced experimental rigor with ecological authenticity, capturing digital vocabulary learning as a multidimensional process rather than reducing it to isolated variables.

Results

This section reports quantitative and qualitative findings related to vocabulary development and depth of processing. Results are presented in five parts: descriptive trends, intervention effects, reliability analyses, longitudinal modelling, and qualitative evidence. All analyses are based on the final analytic sample of 93 participants with complete data.

Descriptive Trends in Vocabulary Development

Table 3 presents mean scores for vocabulary breadth and depth across three testing points. Both measures improved from pre-test to post-test.

Vocabulary breadth increased from 53.1 (SD = 8.1) to 60.4 (SD = 8.7), a statistically significant gain ($p < .001$). At delayed testing, breadth declined slightly to 58.9 (SD = 8.4), though the decrease remained significant ($p < .05$).

Vocabulary depth followed a similar pattern. Mean WAT scores rose from 37.8 (SD = 6.9) to 44.6 (SD = 7.4) at post-test ($p < .001$). At delayed testing, scores remained stable ($M = 43.7$, $SD = 7.2$), with no significant decline.

These findings suggest that vocabulary depth gains were more resistant to attrition than breadth gains.

Table 3

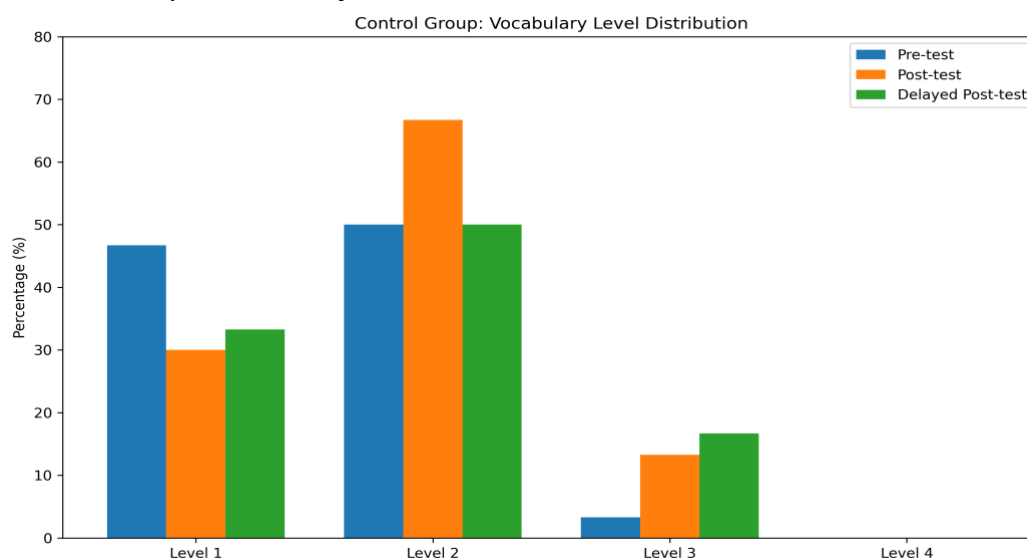
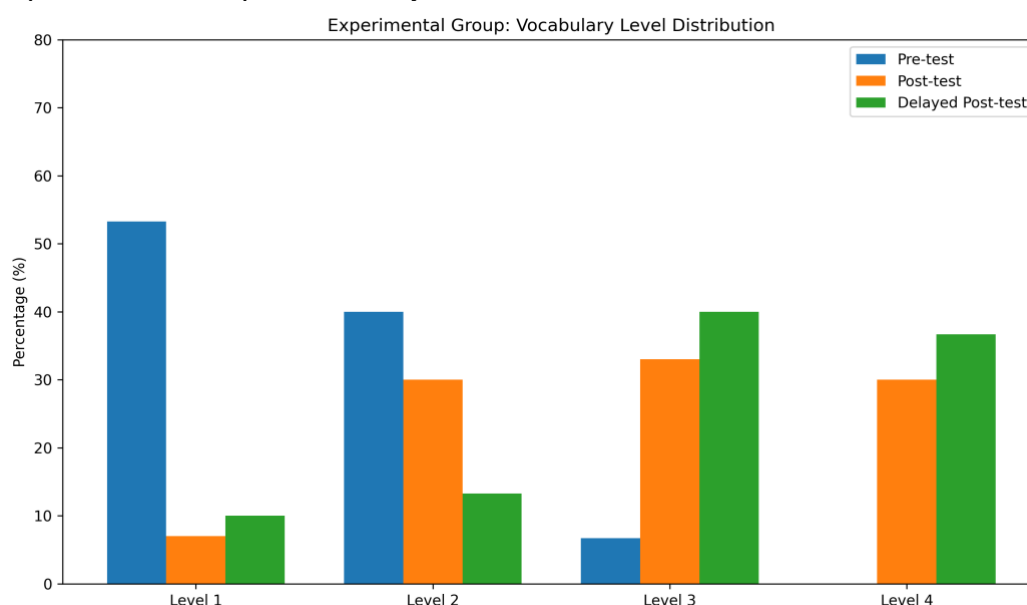
Vocabulary Scores Across Time (N = 93)

Measure	Pre-test (M, SD)	Post-test (M, SD)	Delayed Test (M, SD)
Vocabulary Breadth (VST)	53.1 (8.1)	60.4 (8.7)	58.9 (8.4)
Vocabulary Depth (WAT)	37.8 (6.9)	44.6 (7.4)	43.7 (7.2)

Note. * $p < .05$, ** $p < .01$, *** $p < .001$; ns = not significant.

Intervention Effects

A 2×3 mixed ANOVA examined group and time effects on vocabulary depth. A significant main effect of Time confirmed overall development. A significant Group $\times$ Time interaction, $F(2, 182) = 6.4$, $p = .002$, indicated stronger gains for the treatment group. Participants receiving micro-prompts showed larger improvements from pre-test to post-test and maintained higher delayed scores than the control group (see Figure 1 and Figure 2). These results suggest that micro-prompts enhanced durable lexical depth rather than producing short-term gains only.

Figure 1*Control Group: Vocabulary Level Distribution***Figure 2***Experimental Group: Vocabulary Level Distribution*

Reliability of Instruments

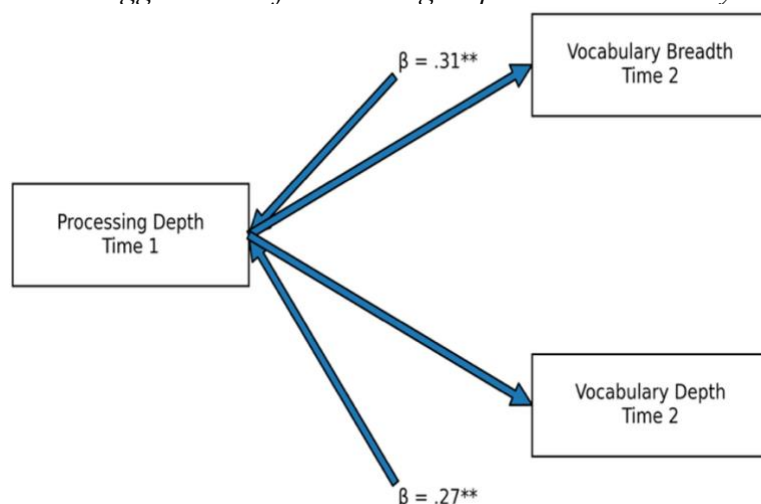
Cronbach's alpha values ranged from .78 to .84 across questionnaire subscales (Table 4), exceeding the .70 threshold for acceptable reliability. These results support the internal consistency of engagement, regulation, and affective orientation measures.

Table 4*Reliability Statistics (N = 93)*

Subscale	Items	Cronbach's α
Engagement	8	.80
Regulation	7	.83
Affective orientation	6	.79

Cross-Lagged SEM: Directional Relationships

A cross-lagged structural equation model (SEM) was conducted to examine directional relationships between processing depth and vocabulary knowledge across time (see Figure 3). As shown in Figure 3, processing depth at Time 1 significantly predicted vocabulary breadth ($\beta = .31, p < .01$) and vocabulary depth ($\beta = .27, p < .01$) at Time 2. In contrast, the reverse paths were not statistically significant. Vocabulary knowledge at Time 1 did not predict subsequent processing depth, indicating that elaborative engagement preceded lexical development rather than resulting from it. These findings remained stable despite the reduced sample size.

Figure 3*Cross-Lagged SEM of Processing Depth and Vocabulary Outcomes (N = 93)***Qualitative Insights: Mechanisms of Engagement**

A thematic analysis of 72 student reflections was conducted using grounded theory principles. Three dominant themes emerged.

Strategic Engagement

Learners who paused to check meanings, generated example sentences, or saved unfamiliar words demonstrated stronger vocabulary gains. This pattern aligns with the SEM findings, reinforcing the role of deeper processing in lexical development.

Motivational Anchors

Many participants linked their engagement to positive L2 self-perceptions and emotional investment. Students in the treatment group described micro-prompts as useful reminders that encouraged intentional focus during digital activities.

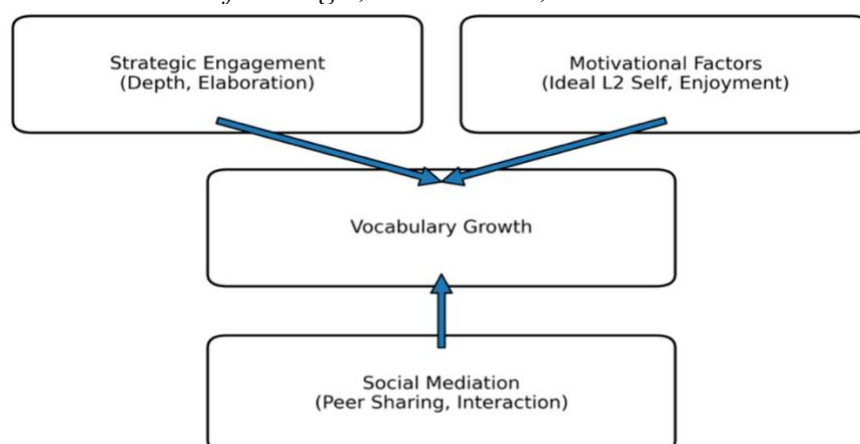
Social Reinforcement

Vocabulary learning was often supported through peer interaction, including sharing captions, memes, and jokes. These exchanges provided contextualized repetition and strengthened retention.

Collectively, the themes indicate that vocabulary growth is enhanced when cognitive effort is supported by motivation and socially embedded interaction. The relationships among these themes are illustrated in Figure 4.

Figure 4

Thematic Model of Strategic, Motivational, and Social Factors



Taken together, the findings present a coherent account of informal digital vocabulary learning. Quantitative results show gains in both breadth and depth, with stronger durability in depth. Experimental comparisons confirm the effectiveness of micro-prompts in enhancing collocational knowledge. Reliability analyses support the consistency of self-report measures, while SEM modelling identifies processing depth as a directional predictor rather than a byproduct. Qualitative evidence further clarifies the cognitive and social mechanisms underlying these outcomes.

Overall, the results indicate that digital exposure alone does not ensure robust vocabulary growth. What matters is how learners process input, strategically, reflectively, and socially. These findings carry clear implications for EFL pedagogy in digitally mediated environments where engagement quality varies.

Discussion

Depth of Processing as the Central Mechanism of Lexical Development

The findings indicate that vocabulary growth in digital environments depends less on exposure frequency and more on how learners process lexical input. Although both groups

improved in vocabulary breadth, only the treatment group maintained stable gains in depth at delayed testing. This pattern suggests that micro-prompts supported sustained elaboration rather than short-term recognition. Breadth gains, while evident, were more vulnerable to attrition.

These results align with Craik and Lockhart's (1972) Depth of Processing framework. In contrast to studies that equate digital learning with time spent online (Lee, 2017; Peters, 2019), the present findings show that surface interaction may support short-term breadth growth, but durable lexical development requires deeper engagement. Learners exposed to identical digital input achieved different outcomes depending on how they processed it. This underscores the limits of quantity-based indicators, such as screen time or content volume, as reliable predictors of vocabulary learning. The results therefore support a shift from exposure-driven models toward quality-oriented accounts of informal digital engagement. Vocabulary development appears shaped primarily by elaboration, reflection, and strategic reuse rather than passive consumption.

Self-Regulated Learning and Strategy Activation

The study also highlights the role of self-regulatory behavior in digital vocabulary learning. Learners in the treatment group who paused to save, reuse, and reflect on unfamiliar words demonstrated more stable depth gains at delayed testing. These patterns are consistent with Zimmerman's (2000) Self-Regulated Learning (SRL) model, which conceptualizes learning as a cyclical process involving planning, monitoring, and evaluation.

However, regulatory behaviors did not consistently emerge spontaneously. Instead, they were often triggered by scaffolded micro-prompts. This suggests that learners may not automatically interpret digital engagement as a learning opportunity without explicit cues. Micro-prompts functioned as catalysts, encouraging learners to notice, monitor, and revisit vocabulary in real time.

At the same time, SRL does not operate in isolation. Regulatory behaviors interacted with cognitive elaboration and motivational orientation. Self-regulation therefore appears as a facilitating mechanism within a broader network of processes rather than a singular explanation for vocabulary retention.

Motivation and the Affective Dimension of Engagement

Motivation also shaped how learners responded to digital vocabulary encounters. Reflections indicated that learners with future-oriented aspirations related to English proficiency were more likely to pause and engage with unfamiliar words. These patterns resemble features of the Ideal L2 Self, although they were inferred qualitatively rather than measured through validated scales. Emotional engagement further influenced vocabulary processing. Many learners described digital content as enjoyable, humorous, or personally meaningful. Such positive affect appeared to increase attentional focus and willingness to engage with lexical input. These observations are consistent with Dewaele and MacIntyre's (2014) argument that enjoyment facilitates deeper processing and communicative engagement. Importantly, motivation was not purely internal. Learners frequently referenced peer expectations, academic advancement, and professional aspirations within the Saudi higher education context. English proficiency was associated with social mobility and institutional recognition. This layered motivational ecology challenges individualistic accounts of digital learning and

highlights the intersection of personal goals and sociocultural pressures. Although affect and motivation were not quantitatively measured in this study, the qualitative evidence suggests that emotional investment enhances responsiveness to strategic scaffolds. Motivation, enjoyment, and regulatory behavior appear to operate in interaction rather than independently.

Social Mediation and Cultural Embeddedness

A notable contribution of this study is its attention to social mediation in informal digital learning. Participants frequently engaged with vocabulary through socially situated practices, including sharing memes, captions, and humorous exchanges. These interactions provided contextualized repetition and reinforced retention beyond solitary exposure. These patterns align with Vygotsky's (1978) Sociocultural Theory, which emphasizes the mediating role of interaction in cognitive development. Digital platforms functioned not only as input channels but also as spaces for collaborative meaning-making. Learners negotiated meaning, personalized language, and responded to peers' usage, embedding vocabulary within communicative practice. Within the Saudi context, digital engagement often occurs within peer networks and shared routines. Reflections suggested a preference for collaborative humor and collective participation. While cultural interpretations remain tentative, the findings challenge assumptions that informal digital learning is primarily individualistic. Instead, vocabulary development appears socially distributed and culturally situated.

Toward an Integrated Model of Digital Vocabulary Learning

The findings highlight the limitations of relying on a single theoretical framework. Depth of Processing explains how lexical items are elaborated but does not fully account for sustained engagement. Self-regulated learning clarifies strategic behavior yet may underestimate the role of contextual scaffolding. Motivational models illuminate aspiration and identity but overlook social mediation. Sociocultural perspectives foreground interaction but may underplay individual variation in strategy and affect. The present study integrates these dimensions within a unified analytical framework. Vocabulary growth emerged from the interaction of cognitive elaboration, regulatory scaffolding, motivational alignment, and social reinforcement. These processes were mutually reinforcing rather than independent.

Accordingly, vocabulary development in informal digital contexts cannot be reduced to time online or volume of exposure. Durable learning occurs when exposure is accompanied by strategic processing, emotional investment, and socially mediated reinforcement. Future digital interventions should therefore activate this multidimensional synergy rather than focusing solely on input frequency.

Conclusion

This study examined how informal digital habits shape vocabulary growth among Saudi EFL learners through a convergent mixed-methods design involving 93 participants. Three key findings emerged. First, both vocabulary breadth and depth improved over time, with stronger and more durable gains in depth among the treatment group. This highlights the importance of engagement quality over exposure quantity and supports the Depth of Processing framework. Second, cross-lagged SEM showed that processing depth predicted subsequent vocabulary growth, positioning elaboration and strategic engagement as likely causal mechanisms. Third, qualitative findings revealed that vocabulary learning was

motivationally and socially mediated, with enjoyment, peer interaction, and future-oriented L2 self-concepts shaping sustained engagement.

Collectively, these findings contribute both pedagogically and theoretically. Pedagogically, they underscore the value of scaffolding self-regulation in informal digital contexts through micro-prompts, reflective activities, and socially embedded practices. Theoretically, the study integrates Depth of Processing, Self-Regulated Learning, the L2 Motivational Self System, and Sociocultural Theory into a multidimensional model of digital vocabulary development.

Limitations

Several limitations should be acknowledged. Reliance on self-report instruments may have introduced subjectivity and recall bias. The 14-day intervention limited insight into long-term development, and optional passive logging reduced the availability of behavioral data. The use of a single-institution convenience sample and the exclusive focus on male learners constrain generalizability. Nevertheless, triangulation across tests, surveys, experience sampling, and usage logs strengthened internal validity. Future research should employ longer interventions, multi-site and mixed-gender samples, fully randomized designs, and systematic behavioral tracking to enhance ecological and external validity.

Practical Implications

For teachers, digital exposure alone is insufficient; embedding micro-prompts, reflection tasks, and sentence-generation activities can deepen processing and support retention. For learners, active elaboration and strategic reuse of vocabulary are essential for durable gains. For institutions and policymakers, self-access platforms should incorporate regulatory and motivational scaffolds aligned with broader educational priorities. For researchers, greater use of ecologically grounded tools is needed to examine how motivation, regulation, and social mediation interact across contexts.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

Generative AI tools (ChatGPT, OpenAI) were used in a limited manner for language editing and stylistic refinement. They were not used for data analysis, interpretation, or content generation. The author remains fully responsible for the accuracy and integrity of the manuscript.

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Contact emails: mh_alshaikhi@ut.edu.sa
shaikhi33@hotmail.com

The Impact of AI-Driven Speaking Practice in VR on Foreign Language Anxiety Among Japanese EFL Learners

Yukie Saito, Chuo University, Japan

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Abstract

This study examined whether speaking practice with AI-driven avatars in a virtual reality (VR) environment was associated with changes in foreign language anxiety (FLA) among Japanese university students preparing for a short-term study abroad program. Using a quantitative pre-experimental pre-test/post-test design, 10 of 12 participants provided complete matched questionnaire data. During one month prior to departure, students completed structured, self-directed speaking practice in Immerse VR by interacting with AI avatars. FLA was assessed before and after the intervention using a 24-item measure adapted from the Foreign Language Classroom Anxiety Scale (Horwitz et al., 1986) rated on a 5-point Likert scale (higher scores indicating greater anxiety). Mean FLA decreased from pre-test ($M = 3.304$, $SD = 0.594$) to post-test ($M = 2.471$, $SD = 0.880$), corresponding to a mean difference of 0.833 points. The pre-post change was statistically significant ($p = .001$) and the estimated effect size was large (Cohen's $d = 1.518$, direction indicating lower post-test anxiety). Internal consistency was high at both time points ($\alpha = .922$ pre; $\alpha = .967$ post). Exploratory analyses did not show a clear association between time spent in Immerse VR and anxiety change. Because there was no control group and the sample was small, it is difficult to determine whether the observed effects were truly caused by the intervention, and the findings cannot generalize widely. Future studies with larger, controlled designs could clarify whether AI-mediated VR speaking practice helps reduce anxiety before a study abroad program.

Keywords: virtual reality, foreign language anxiety, Japanese EFL students, AI avatars, study abroad preparation

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Introduction

The number of Japanese university students studying abroad has been increasing over the past few years, following a significant decline during the COVID-19 pandemic. To maximize the opportunity to study abroad, students are expected to be well prepared to communicate in English. However, foreign language anxiety (FLA) may prevent students from communicating in English even when they have sufficient linguistic knowledge. This is particularly salient for Japanese university students who learn English as a foreign language, where exposure to English is limited. The recent integration of virtual reality (VR) and generative AI may help address this challenge, particularly through VR-based AI avatars, because students can practice speaking with AI avatars at any time outside class.

In this study, Japanese university students practiced speaking with AI avatars on a VR language platform, Immerse VR, for one month prior to a four-week study abroad program. To evaluate whether this speaking practice can reduce their foreign language anxiety, pre- and post-intervention FLA questionnaires were collected. Using a quantitative matched pre-test/post-test design, this paper reports preliminary findings focusing specifically on changes in FLA. An exploratory analysis also considers whether total time spent on the platform (Time on Site; TOS) is related to the magnitude of FLA change. The study addresses the following research question: Does practicing speaking with AI avatars in a VR environment reduce foreign language anxiety among Japanese university students preparing to study abroad?

Literature Review

VR: Definition, Educational Potential and Application to Language Education

Virtual reality (VR) refers to a computer-generated, immersive three-dimensional environment designed to simulate realistic experiences, providing visual feedback that dynamically responds to user movements (Dionisio et al., 2013). By means of interactive simulations, VR allows participants to engage in settings that closely replicate real-world scenarios, thereby facilitating a high level of immersion. Given its advanced immersive features, VR is anticipated to have extensive applications across various fields, including retail, entertainment, education, industrial training, healthcare, fitness, and social engagement (Hamad & Jia, 2022). Notably, numerous studies have highlighted the potential of VR within educational environments (Hu-Au & Lee, 2017).

In language education, VR is often used to create situationally rich interaction that resembles everyday communication and may help maintain learners' attention and support retention (Scrivner et al., 2019). Research on virtual learning environments suggests that interactive and authentic contexts can promote autonomy and confidence, and may also alleviate anxiety by providing practice opportunities that are not easily available in daily life (Lin & Lan, 2015). Recent syntheses and empirical studies increasingly indicate that VR-supported activities can improve oral performance and related outcomes, including oral presentation performance and speaking development, together with affective benefits (Chen et al., 2022; Qiu et al., 2024). Task-based VR research further points to potential gains in willingness to communicate, fluency, pronunciation, and confidence (Ebadi & Ebadijalal, 2020; Liu & Hou, 2020). Simultaneously, review studies indicate that while motivational gains and reduced anxiety are commonly observed, the evidence supporting substantial and consistently replicable enhancements in speaking fluency remains inconclusive (Yudintseva, 2023).

A critical factor in interpreting VR effects is the degree of immersion. High-immersion VR (HiVR), typically delivered via head-mounted displays, can produce stronger presence than low-immersion VR (LiVR) delivered via standard 2D displays (Kaplan-Rakowski & Gruber, 2019). HiVR has been reported to be more engaging and motivating than LiVR (Makransky & Lilleholt, 2018), but it may also introduce constraints such as motion sickness, eye strain, and higher cost (Dolgunsöz et al., 2018; Kaplan-Rakowski & Wojdyski, 2018). Accordingly, evaluating VR in language education may require attention not only to the presence of VR, but also to the level of immersion and the practical feasibility of sustained use over time.

AI and Generative AI for Speaking Practice

In parallel with VR, AI-supported language learning tools have expanded opportunities for interactive practice. The studies of AI-mediated instruction have reported improvements in speaking-related outcomes, motivation, and self-regulated learning compared with traditional instruction (Qiao & Zhao, 2023; Wei, 2023). Generative AI tools (e.g., ChatGPT) may enhance this potential by providing EFL learners with limited opportunities for English communication a means to practice speaking beyond the classroom. Recent studies report perceived benefits including expanded speaking opportunities and improvements in confidence or speaking self-efficacy (Muniandy & Selvanathan, 2024; Üstünbaş, 2024; Yıldız, 2024). Together, these lines of work suggest that AI may function as a conversational partner, potentially reducing fears often associated with speaking practice.

AI Avatars in VR: Early Evidence and Remaining Gaps for FLA

Several VR language platforms (e.g., Mondly VR, Ovation VR, Immerse VR) now incorporate AI avatars that allow learners to practice speaking in simulated real-world environments. Initial research suggests that avatar-based VR practice is often perceived as motivating and enjoyable, and may support confidence-building, though it can also increase fatigue or be affected by physical classroom constraints such as noise (Kawasumi & Ishii, 2023; Thrasher et al., 2024). Exploratory findings further suggest that VR practice combined with feedback may help reduce speaking anxiety in some contexts (Godefridi et al., 2021). Nevertheless, empirical evidence remains limited regarding whether speaking with AI avatars in immersive VR produces measurable reductions in foreign language anxiety (FLA), and how such changes relate to engagement metrics (e.g., time on platform).

Although the broader project of the present study collected multiple forms of data (e.g., speaking proficiency and learner perceptions), this paper reports preliminary results focusing specifically on FLA following a one-month AI-driven VR speaking intervention. This focused scope is intended to provide an initial estimate of the intervention's potential affective impact and to establish a foundation for subsequent analyses that integrate additional variables.

To support English learners before their study abroad program, speaking practice environments that reduce pressure are needed. Technology-mediated speaking practice may offer a low-stakes way for learners to rehearse communication in English. Building on this premise, the present study examines whether an AI-driven VR speaking intervention can reduce FLA among Japanese university students preparing to study abroad. Accordingly, this study investigates the efficacy of an AI-driven VR speaking intervention for Japanese university students preparing to study abroad. The primary research question is: Does practicing speaking with AI avatars in a VR environment reduce foreign language anxiety among Japanese university students preparing to study abroad?

Methodology

Research Design and Scope

This study employed a quantitative, pre-experimental design using a matched pre-test/post-test approach to examine changes in foreign language anxiety (FLA) following an AI-driven VR speaking intervention. Although the broader project collected additional data (e.g., speaking proficiency and learner perceptions), the present paper reports preliminary results focusing exclusively on FLA.

Participants

Twelve Japanese university students participated in a one-month ICT-focused study abroad program in Australia, where they took General English and IT-related courses. All participants were enrolled at a Japanese university and were preparing for an upcoming English-speaking environment abroad. Before the program, they practiced speaking with AI avatars in a VR environment. Matched pre- and post-intervention questionnaire data were obtained from 10 students.

Intervention and Procedure

The intervention consisted of one month of structured speaking practice using Immerse VR, a VR language-learning platform. Participants interacted with AI-powered avatars multiple times and were instructed to practice daily at home on their PCs (LiVR) during the one-month period in preparation for studying abroad. A pre-intervention questionnaire was administered before the practice period, and a post-intervention questionnaire was administered after the one-month intervention. Usage data from Immerse VR—recorded as Time on Site (TOS)—were obtained to examine the relationship between changes in foreign language anxiety (FLA) and TOS.

Foreign Language Anxiety (FLA) Questionnaire

FLA was assessed using a questionnaire adapted from the Foreign Language Classroom Anxiety Scale (FLCAS; Horwitz et al., 1986). The adapted instrument consisted of 24 items rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). For analysis, item responses were averaged to compute a mean FLA score for each participant at each time point, with higher scores indicating greater anxiety. Internal consistency reliability was examined using Cronbach's alpha at both administrations.

Data Analysis

Descriptive statistics (means and standard deviations) were calculated for pre- and post-intervention FLA scores. A matched pre-test/post-test comparison was conducted to evaluate whether the change in FLA was statistically significant. Effect size was calculated using Cohen's *d* to quantify the magnitude of change. Scale reliability was assessed using Cronbach's alpha. Exploratory correlational analyses examined (a) the association between change in FLA and time on site (TOS) and (b) the relationship between baseline FLA and TOS. Statistical significance was evaluated at an alpha level of .05.

Results

Matched pre- and post-intervention questionnaire data were available for 10 participants. Foreign language anxiety (FLA) was operationalized as the mean score across Items 1–24 on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), with higher scores indicating greater anxiety. Internal consistency of the 24-item scale was excellent at both time points (Cronbach's $\alpha = .922$ at pre-test; $\alpha = .967$ at post-test; $N = 10$), supporting the reliability of the adapted measure in this sample.

Descriptive Change in FLA From Pre-test to Post-test

Descriptive statistics indicated a decrease in FLA following the intervention (Table 1). Mean FLA decreased from $M = 3.304$ ($SD = 0.594$) at pre-test to $M = 2.471$ ($SD = 0.880$) at post-test, corresponding to a mean change (post – pre) of -0.833 points (approximately 25% of the pre-test mean). The distribution shifted downward as well: the observed range moved from 2.542–4.250 at pre-test to 1.125–3.875 at post-test. The reduction was also evident at the upper end of the distribution, with the post-test maximum (3.875) lower than the pre-test maximum (4.250), suggesting fewer extremely high anxiety scores after the intervention.

Table 1

Pre- and Post-test FLA Scores

Scale	N	Pre M	Pre SD	Post M	Post SD	Range (Pre)	Range (Post)
FLA (Q1–Q24)	10	3.304	0.594	2.471	0.880	2.542–4.250	1.125–3.875

Despite the overall decrease, post-test scores were more dispersed than pre-test scores ($SD: 0.594 \rightarrow 0.880$), indicating greater heterogeneity at post-test. This pattern suggests that participants did not converge on a similar post-intervention anxiety level; rather, some showed large decreases while others showed modest decreases, resulting in a wider spread of post-test outcomes even as the group mean declined.

Inferential Test of Pre–Post Difference

A paired-samples t test showed that FLA decreased significantly from pre-test to post-test, $t(9) = -4.79$, $p = .0010$. The mean change (post–pre) was -0.833 , with a 95% confidence interval of $[-1.225, -0.439]$. The within-participant effect size was large ($d_{\text{within}} = -1.52$), indicating a substantial reduction relative to within-participant variability.

Given the small sample size and the potential sensitivity to parametric assumptions, a Wilcoxon signed-rank test was conducted as a nonparametric robustness check. The Wilcoxon test corroborated the reduction, $W = 0$, $p = .00098$, providing convergent evidence that the pre–post decrease in FLA is not dependent on the parametric model.

Individual-Level Pattern

To assess whether the group-level effect reflected a general pattern rather than being driven by a small subset of participants, individual pre–post changes were examined. All 10 participants showed lower FLA at post-test than at pre-test (i.e., $\Delta FLA < 0$ for every participant), indicating a directionally consistent decrease across the sample. However, the magnitude of change varied

substantially, ranging from -0.13 to -2.00 points, consistent with the increased post-test variability noted above.

The largest reduction was observed for Student I ($\Delta\text{FLA} = -2.00$), whereas the smallest reduction was observed for Student E ($\Delta\text{FLA} = -0.13$). The median change was -0.77 , with an interquartile range (IQR) of approximately 0.65 , suggesting moderate-to-large typical decreases but notable individual differences. Using practical thresholds, 7 of 10 participants showed decreases of ≥ 0.50 points and 4 of 10 showed decreases of ≥ 1.00 point, indicating that the mean reduction was not driven by a single extreme case but reflected decreases across multiple participants.

Platform Use (Time on Site; TOS): Descriptive Statistics and Exploratory Associations

Time on Site (TOS) captured how long each participant engaged with the VR platform outside of class. In the matched sample ($N = 10$), engagement varied widely. Participants spent an average of 8.86 hours on the platform ($SD = 7.78$), with a median of 7.32 hours, indicating that the mean was influenced by a small number of high-use observations. TOS ranged from 0.78 to 28.83 hours, suggesting a right-skewed distribution and pronounced between-participant differences in exposure.

Exploratory correlational analyses examined whether TOS was related to (a) the magnitude of anxiety reduction (ΔFLA) and (b) baseline anxiety (pre-test FLA). Because TOS showed substantial dispersion and included an extreme high-exposure participant, both Pearson's r (linear association; outlier-sensitive) and Spearman's ρ (rank-based; more robust to non-normality and outliers) were reported. TOS was not associated with anxiety reduction (ΔFLA) in this sample (Spearman's $\rho = 0.042$, $p = .907$; Pearson's $r = -0.132$, $p = .715$).

For baseline anxiety (pre-test FLA), Pearson's correlation indicated a positive association with TOS ($r = 0.663$, $p = .037$), whereas Spearman's correlation was not statistically significant ($\rho = 0.604$, $p = .065$). This discrepancy may reflect sensitivity to distributional features such as right-skew and/or outlier influence. Substantively, the direction of the association is consistent with the possibility that participants with higher initial anxiety tended to spend more time on the platform, but this interpretation remains tentative.

Discussion

This preliminary study examined whether a one-month AI-driven VR speaking intervention was associated with reduced foreign language anxiety (FLA) among Japanese university students preparing for study abroad. Overall, FLA decreased significantly from pre-test to post-test with a large within-participant effect, and all participants showed reductions. This pattern is broadly consistent with prior work suggesting that technology-mediated and VR-supported environments can provide low-stakes opportunities for practice that foster confidence and reduce anxiety by minimizing immediate social evaluation (e.g., Chen et al., 2022; Lin & Lan, 2015; Qiu et al., 2024). In the Japanese EFL context described in the Introduction—where spontaneous speaking opportunities are limited and fear of negative evaluation can constrain participation—an AI-avatar environment may function as a psychologically safer “rehearsal space,” helping learners acclimate to real-time speaking demands before going abroad.

At the same time, participants' post-test FLA scores were more dispersed than pre-test scores, indicating heterogeneous responses to the intervention. Nonetheless, the overall pattern was a

clear reduction in FLA from pre- to post-test, suggesting that even low-immersion VR (LiVR) can be associated with lower foreign language anxiety. This combination of a reliable mean decrease alongside increased variability aligns with reviews noting that affective outcomes in VR are not uniformly large or consistent and may depend on learner characteristics and implementation conditions (e.g., Yuditseva, 2023). The immersion literature offers one possible perspective: high-immersion VR (HiVR) can heighten presence and engagement (Kaplan-Rakowski & Gruber, 2019; Makransky & Lilleholt, 2018), but it can also introduce constraints such as fatigue, discomfort, and classroom practicality issues (Dolgunsöz et al., 2018; Kaplan-Rakowski & Wojdyski, 2018). In this context, the present LiVR approach appears sufficient to reduce FLA on average, yet the wider spread of post-test scores suggests that the magnitude of anxiety reduction may vary across learners. Importantly, these findings raise the possibility that lowering FLA may not require HiVR; for some learners, more accessible LiVR practice may provide comparable affective benefits, although direct HiVR–LiVR comparisons are needed to determine whether immersion level moderates anxiety-related outcomes.

Exploratory analyses relating platform engagement (Time on Site; TOS) to outcomes further suggest that the time that learners spent on the platform to practice speaking with AI avatars is not related to anxiety reduction. Despite wide variation and a right-skewed TOS distribution, TOS showed no evidence of association with the magnitude of anxiety reduction (Δ FLA). This finding is compatible with the idea, highlighted in VR and AI-assisted learning research, that the quality and structure of practice may matter as much as (or more than) raw exposure time. It also resonates with the emerging generative-AI literature suggesting that conversational AI can support self-efficacy and self-regulated learning (e.g., Muniandy & Selvanathan, 2024; Qiao & Zhao, 2023; Wei, 2023), which are not fully captured by total time spent on a platform. Accordingly, richer engagement indicators such as number of sessions, task completion, and interaction depth may be needed to identify which aspects of AI-avatar practice are most closely tied to reduced anxiety.

For baseline anxiety, Pearson's correlation suggested that higher pre-test FLA was associated with greater TOS, whereas Spearman's estimate did not reach conventional significance. Interpreted cautiously, this tentative pattern is consistent with the possibility that more anxious learners sought out more practice because they perceived a greater need to prepare. However, given the small sample and outlier sensitivity, this should be treated as hypothesis-generating. Future work should examine whether baseline anxiety moderates engagement and outcomes (i.e., whether learners with higher initial anxiety both practice more and benefit differently).

These findings should be interpreted with caution in light of several limitations. First, the study employed a pre-experimental design without a control group; therefore, the observed reductions cannot be attributed uniquely to the intervention. Second, the sample was small and context-specific, limiting generalizability and the precision of correlational estimates. Engagement analyses may also have been influenced by the right-skewed TOS distribution. Third, although internal consistency was high, the adapted FLA measure may reflect multiple facets of anxiety. Future studies should triangulate self-report results with speaking-specific anxiety measures, behavioral indicators (e.g., willingness to communicate), and qualitative reflections on perceived evaluative pressure when interacting with AI avatars. Addressing these issues is particularly important because, despite the growing availability of AI-avatar VR platforms, empirical evidence on measurable FLA change—and its relationship to engagement—remains limited.

Conclusion

This study investigated whether a one-month AI-driven VR speaking intervention was associated with reduced foreign language anxiety (FLA) among Japanese university students preparing for study abroad. Using a matched pre-/post-test design ($N = 10$ with complete questionnaires), FLA decreased significantly from pre-test to post-test with a large within-participant effect, and all participants showed reductions. However, the magnitude of improvement varied across individuals, and post-test scores were more dispersed than pre-test scores. Platform engagement (Time on Site; TOS) also varied widely and showed a right-skewed distribution ($N = 10$), but exploratory analyses found no clear association between TOS and the magnitude of anxiety reduction (Δ FLA). A tentative pattern suggested that higher baseline FLA may be associated with greater platform use (Pearson significant; Spearman not), although this finding should be interpreted cautiously given the small sample and outlier sensitivity. Overall, the findings provide preliminary evidence that AI-avatar VR speaking practice may help reduce anxiety prior to study abroad, particularly in contexts such as Japanese EFL where opportunities for spontaneous English speaking are limited.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that ChatGPT, a generative AI software, was used in proofreading and refining the language used in the manuscript. The usage was limited to correcting grammatical and spelling errors and rephrasing statements for accuracy and clarity. The author further declares that, apart from ChatGPT, no other AI or AI-assisted technologies have been used to generate content in writing the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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Normalization and Its Relation to Peace Education Using a Sampling of Montessori Preschools From Around the World

Ritsu Dansako, Kyushu University, Japan

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Abstract

Montessori education is often conceptualized as a form of peace education, with Normalization identified by Montessori as one of the most significant outcomes of her empirical work. Normalization refers to a process through which children, including those with behavioral difficulties, return to a natural path of development. While Montessori described this change as sudden and almost miraculous, the present exploratory study reexamines the timing, processes, and conditions of Normalization and its relationship to peace in the classroom. Using an online survey, data were collected from 48 Montessori preschool teachers across eight countries. The questionnaire focused on teachers' observations of the onset, duration, and outcomes of Normalization, as well as its perceived impact on children's behavior and classroom climate, given the exploratory design and sampling constraints during the COVID-19 pandemic. Responses were analyzed descriptively to identify common patterns and trends across contexts. Two key findings emerged. First, teachers consistently identified children's spontaneous choice of work as the primary trigger for Normalization. Second, contrary to Montessori's original claim, Normalization was most often described as a gradual process, typically unfolding over three to four years during the preschool period rather than occurring suddenly. Most respondents (95%) reported improvements in behavioral problems, and 68% indicated that children maintained a permanent or semi-permanent normalized state.

Keywords: Montessori education, peace education, Normalization

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Introduction

Montessori education is frequently described as a form of peace education, grounded in the belief that peace must be cultivated within the individual before it can be realized in society. Following the devastation of World War II, international organizations such as UNESCO emphasized education as a means to prevent future conflict, asserting that peace must be constructed in the minds of human beings (UNESCO, 2021). Within this global movement, peace education has expanded beyond the mere absence of war to include the development of moral awareness, social responsibility, and non-violent ways of relating to others. However, despite its widespread endorsement, a central challenge remains unresolved: how peace can be effectively fostered through everyday educational practice, particularly in early childhood.

Maria Montessori addressed this challenge by focusing on children's inner development rather than external moral instruction. Although she did not create a formal curriculum labeled "peace education," Montessori consistently argued that education itself is the most powerful means of achieving peace (Montessori, 1949). Central to her educational philosophy is the concept of Normalization, which she identified as the most significant outcome of her empirical observations. Normalization refers to a process through which children, including those displaying what Montessori termed "deviated" behaviors, regain their natural developmental trajectory when placed in a carefully prepared environment that allows freedom of choice and sustained concentration.

Montessori described Normalization as a sudden and almost miraculous transformation in children's character, marked by self-discipline, calmness, and social harmony (Montessori, 1966). She further claimed that normalized children naturally prefer orderly, purposeful activity and demonstrate respect and consideration for others. From Montessori's perspective, these characteristics form the psychological foundation of peace, suggesting a direct connection between individual self-regulation and collective peacefulness in the classroom community.

While Montessori's theoretical claims have been influential and widely cited, empirical research examining precise conditions of Normalization remains limited (Frierson, 2021). In particular, there is little systematic investigation into whether Normalization occurs as a sudden transformation, as Montessori suggested, or as a more gradual developmental process. Moreover, the mechanisms through which individual Normalization may contribute to peace education at the classroom or community level have not been sufficiently articulated.

To address these gaps, the present study investigates Normalization as a key component of Montessori education for peace. Drawing on international survey data from Montessori preschool teachers, this research explores when and how Normalization occurs, what conditions trigger it, and how it is perceived to influence children's behavior and classroom peacefulness. By empirically examining Normalization in contemporary Montessori settings, this study seeks to clarify its role as a foundational process linking individual development to peace education.

This study contributes to international discussions on peace education by providing empirically grounded insights into how Montessori-based practices, particularly children's spontaneous choice of work, support the gradual development of peaceful classroom communities across diverse cultural contexts.

Literature Review

Peace Education in the Global Context

Peace education emerged as a distinct field in the aftermath of World War II, shaped by efforts to prevent the recurrence of large-scale violence and to promote international understanding. Influenced by peace research and conflict studies, the field developed primarily in Europe and the United States from the 1950s onward (Murakami, 2009). Scholars gradually broadened the concept of peace beyond the absence of war to include the elimination of structural violence, social injustice, and inequality. As a result, peace education curricula increasingly addressed issues such as human rights, poverty, racism, and environmental sustainability.

International organizations and academic networks have played a central role in advancing peace education research and practice. UNESCO's "culture of peace" framework emphasized the cultivation of values, attitudes, and behaviors that support peaceful coexistence. Similarly, organizations such as the International Peace Research Association (IPRA) and the Peace Education Committee (PEC) promoted interdisciplinary research and the development of educational materials aimed at fostering peace at local and global levels. Despite these advances, scholars have noted that peace education is deeply shaped by historical, cultural, and sociopolitical contexts, resulting in diverse interpretations and implementations across countries (Wintersteiner, 2004).

Peace Education in Japan

In Japan, peace education has been strongly influenced by the nation's experience of World War II, including the atomic bombings of Hiroshima and Nagasaki. Early peace education efforts focused primarily on transmitting historical knowledge and fostering anti-war sentiments through remembrance of past atrocities (Murakami, 2009). While this approach played an important role in shaping collective memory, critics have argued that it often emphasized factual knowledge at the expense of developing critical thinking and proactive peacemaking skills (Langager, 2009).

More recent scholarship has documented a gradual shift in Japanese peace education toward a more future-oriented and comprehensive approach. This emerging model incorporates themes such as human rights, social responsibility, and global citizenship, aligning more closely with international perspectives on peace education. Nevertheless, concerns have been raised about the potential psychological impact of exposing young children to traumatic historical content without sufficient consideration of developmental readiness, highlighting the need for age-appropriate approaches to peace education (Muramoto, 2014).

Deviation and Normalization in Montessori Theory

Within this broader context, Montessori education offers a distinctive perspective on peace education by focusing on children's developmental conditions. Montessori introduced the concept of deviation to describe behaviors resulting from obstacles to normal development, emphasizing that such behaviors are not inherent flaws but responses to inadequate environments. According to Montessori, children who experience deviation are unable to learn effectively and may carry maladaptive patterns into later life.

Normalization, in contrast, represents a healing process through which children return to their natural developmental path (O'Shaughnessy, 2016). Montessori argued that Normalization occurs when children are provided with a carefully prepared environment that supports freedom of choice, purposeful activity, and sustained concentration. Through repeated engagement in meaningful work, children develop self-discipline, independence, and inner calm. Contemporary researchers have suggested that this process closely corresponds to the modern psychological concept of self-regulation.

Normalization as Education for Peace

Montessori maintained that Normalization forms the foundation of education for peace, as normalized children naturally exhibit social harmony, cooperation, and respect for others (Montessori, 1949, 1966). Rather than teaching peace as an external moral concept, Montessori education aims to cultivate inner peace through developmental processes, a view further articulated in contemporary Montessori scholarship (Lillard, 2005, 2017). Empirical studies across diverse cultural contexts have reported positive social, emotional, and cognitive outcomes associated with Montessori education, suggesting its relevance to peace education (Lillard & Else-Quest, 2006; Rathunde & Csikszentmihalyi, 2005).

Although a growing body of research has documented positive outcomes associated with Montessori education, empirical investigation of the *process* of Normalization itself remains limited (Lillard, 2019). Existing studies have largely relied on qualitative descriptions, case studies, or long-term outcome measures, providing limited insight into when and how Normalization unfolds in everyday classroom practice. Moreover, relatively few studies have examined Normalization from the perspective of practicing Montessori teachers or employed cross-cultural data (Duckworth, 2006; Murray & Peyton, 2008). To address these gaps, the present study offers an exploratory international analysis of teachers' observations of Normalization and examines how this process may link individual developmental change to the emergence of peaceful classroom communities.

Despite extensive theoretical discussion of Normalization within Montessori scholarship, empirical research examining its developmental processes, particularly from teachers' perspectives, remains limited. Moreover, few studies have investigated Normalization in relation to peace education using cross-cultural data. This study addresses these gaps by offering an exploratory international analysis of how Normalization unfolds in practice and how it contributes to individual and collective peacefulness in early childhood educational settings.

Taken together, the existing literature highlights a clear need for empirical research that examines Normalization not only as a theoretical construct but as a lived developmental process in contemporary Montessori classrooms. In response to this gap, the present study focuses on how and when Normalization occurs in Montessori preschools serving children from three to six years of age, drawing on survey data from practicing teachers across multiple countries. Specifically, this study investigates the *timing, steps, and circumstances* through which Normalization is observed to unfold. In addition, it examines whether and how this process contributes to the emergence of peaceful conditions within classroom communities. By addressing these questions, the study aims to clarify the role of Normalization as a potential mechanism linking individual developmental change to broader goals of peace education.

Methodology

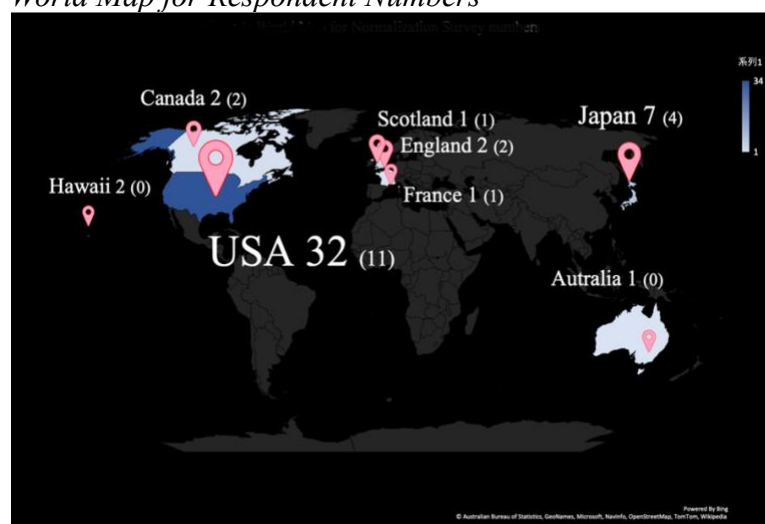
This study was conducted as action research employing a mixed-methods approach that integrates quantitative and qualitative data. Data were collected through an online survey administered via Qualtrics, consisting of 21 questions (Appendix). The survey included both closed-ended items and open-ended questions designed to capture Montessori teachers' observations of the process of Normalization and its relation to classroom peacefulness.

The survey was initially distributed in Japanese within Japan, the researcher's home country, and subsequently administered in English to participants in other countries (Figure 1). Answers in French and Japanese were translated into English for analysis. Target participants were Montessori Infant/Toddler and Early Childhood teachers, as Normalization is theorized to occur primarily between the ages of three and six (Montessori, 2007). Survey invitations were sent by email in mid-February 2022 to Montessori preschools across Europe, Asia, the United States, Canada, and Australia, based on school listings from the Association Montessori Internationale (AMI) website and supplementary Google searches.

A total of 55 responses were received between mid-February and mid-March 2022. After excluding seven incomplete responses in which participants discontinued after providing consent, 48 surveys were retained for analysis. All 48 responses were analyzed for the quantitative items (Question# 1–7). For the qualitative section (Question# 8–13), 21 surveys contained written responses and were included in the qualitative analysis. All but one of these respondents held Montessori teaching credentials. Participants were anonymized and assigned identification numbers from 1 to 48. Ethical considerations were addressed by obtaining informed consent from all participants prior to participation, ensuring voluntary involvement, and anonymizing all responses to protect participants' identities.

Figure 1

World Map for Respondent Numbers



Note. Numbers with complete written answers in the parenthesis.

This study aims to identify common patterns in the occurrence and conditions of Normalization across diverse international contexts, rather than to compare countries. Accordingly, descriptive statistics were used for quantitative data, while thematic analysis was applied to qualitative responses. The majority of the participants were located in the United States, followed by Japan, the United Kingdom, Canada, France, and Australia.

This study has several methodological limitations. First, the sample size was relatively small, partly due to recruitment and data collection constraints during the COVID-19 pandemic. Second, issues of wording in the survey may have led to conceptual ambiguity, for some researchers, as Normalization is understood as a phenomenon rather than a situational behavioral change, which may have contributed to participant confusion and incomplete responses. The high proportion of open-ended questions may also have increased response burden, particularly for participants completing the survey on mobile devices. In addition, language limitations may have affected response completion, as the survey was administered in Japanese and English only. Finally, the study focused on observing children aged three to six, consistent with Montessori theory, but Normalization may occur beyond this age range. These limitations suggest directions for future research, including refined survey design, multilingual instruments, larger samples, and examination of Normalization across broader developmental stages.

Results and Discussions

Drawing on survey data from Montessori teachers in multiple countries, the findings provide empirical insight into the developmental process of Normalization and its broader implications for peace education. The following analysis focuses on teachers' observations of children's behavioral and social changes following Normalization. All participants reported familiarity with the Montessori concept of Normalization, with 90% indicating that they were either extremely or moderately familiar with the concept. Among these respondents, 83% were credentialed Montessori teachers, suggesting a high level of professional understanding, while a small number of non-credentialed participants also reported high familiarity.

Finding 1: Normalization as a Global but Gradual Developmental Process

The results indicate that Normalization is a widely observed phenomenon across diverse Montessori contexts, supporting Montessori's claim that it reflects a universal developmental tendency rather than a culturally specific practice. Teachers from different countries reported remarkably similar observations regarding the conditions under which Normalization occurs and the behavioral changes that follow. Overall, approximately 95% of the participants indicated that behavioral difficulties were addressed through Normalization, suggesting a strong and consistent perception among teachers of its positive impact on children's behavior.

However, the findings challenge Montessori's original description of Normalization as primarily sudden and miraculous. While a small number of cases closely resembled the dramatic transformations documented by Montessori, the majority of respondents described Normalization as a gradual process that unfolds over time. For most children, Normalization first appeared as an initial catalytic event and then gradually stabilized over a period of three to four years within the Children's House (pre-school).

Only approximately 10% of written responses described an immediate and permanent transformation closely aligned with Montessori's early case narratives. In contrast, most teachers reported that children experienced repeated episodes of Normalization that increased in frequency and stability over time. This finding suggests that while sudden Normalization is possible, it is not the dominant developmental pathway in contemporary Montessori classrooms.

Trigger of Normalization: Spontaneous Choice of Work

Across the dataset, one factor emerged with particular consistency: Normalization was most often triggered when children spontaneously chose their own work. Whether the activity was independently selected or introduced by a teacher and then accepted by the child, the defining feature was the child's voluntary engagement.

Teachers emphasized that Normalization did not occur when work was imposed externally. Rather, it emerged when the activity aligned with the child's intrinsic interest and developmental readiness. This finding empirically supports Montessori's emphasis on freedom of choice within a prepared environment and underscores the importance of respecting children's internal motivations.

Practical Life activities were especially prominent in the data, likely due to their direct connection to everyday experiences and their capacity to support sustained concentration. These results reinforce the pedagogical implication that teacher observation and sensitive introduction of materials play a crucial role in facilitating, but not forcing, Normalization.

Time and Consistency of Normalization

A prominent feature of Normalization was heightened concentration, noted in 12 of the 21 qualitative responses, with children demonstrating sustained focus for extended periods. Regarding duration, the most common length of the first Normalization episode was 15 minutes, followed by 30 minutes, although 5 children exhibited markedly longer episodes of 1 to 2 hours (Figure 2). With respect to frequency after the initial occurrence, Normalization was most often reported as "frequently" (nine children), while four reported it infrequently, and none reported it as never occurring again (Figure 3). Overall, these findings indicate that once Normalization first emerges, children tend to re-enter this state repeatedly over time, though with considerable individual variation in duration and frequency.

Figure 2

The Length of the First Normalization (Question 6–4 see Appendix)

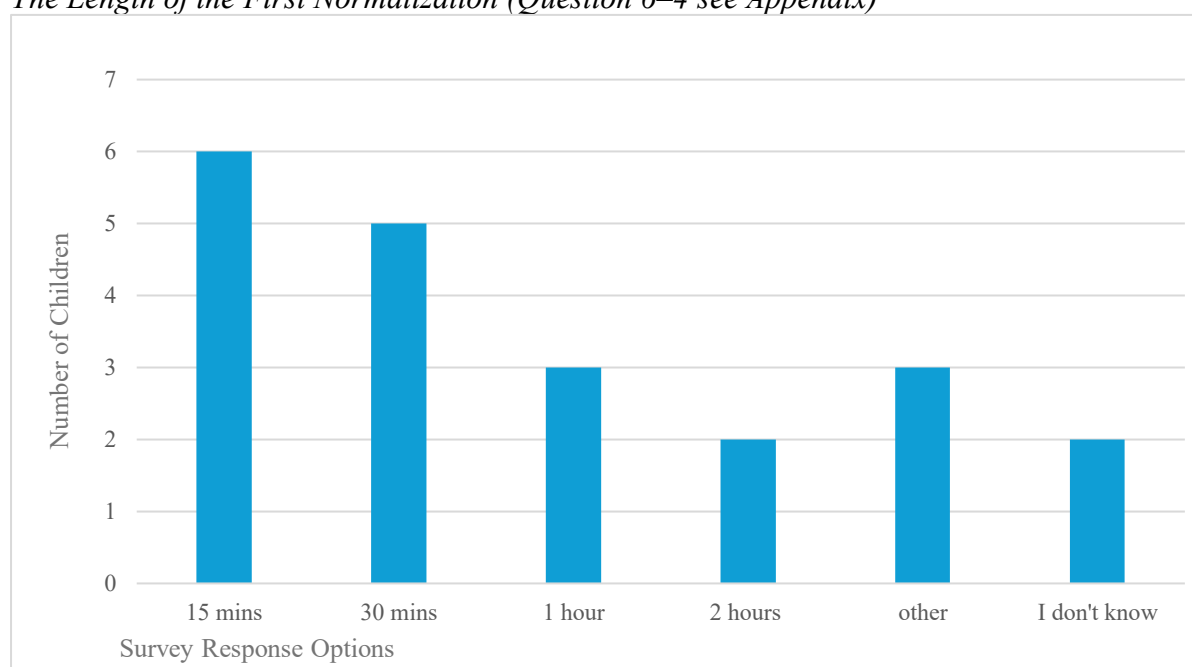
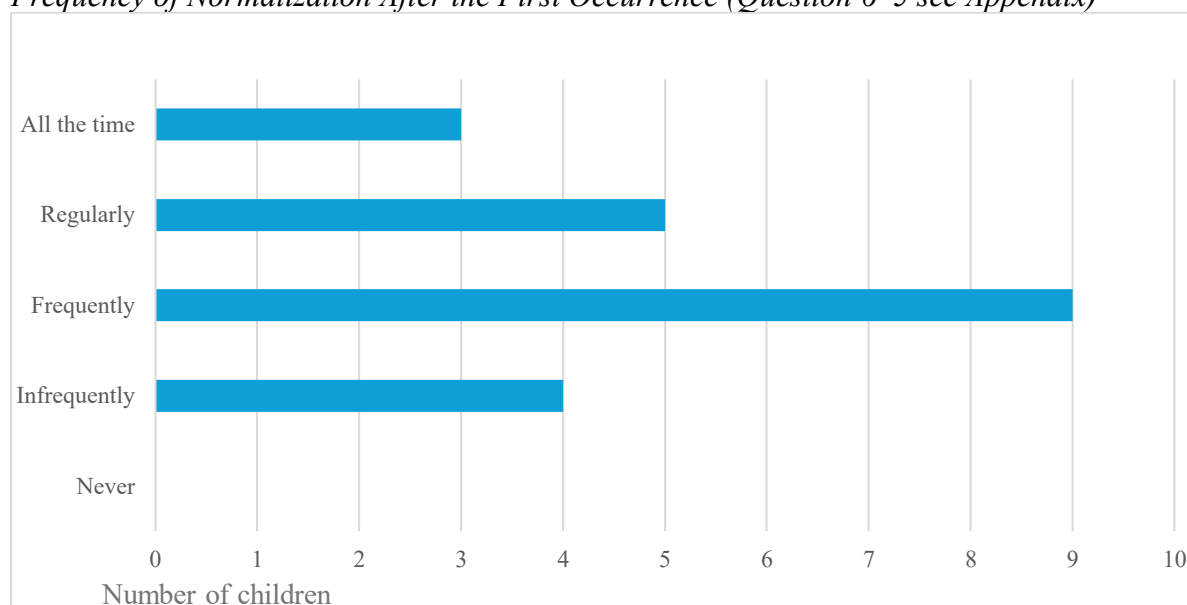


Figure 3*Frequency of Normalization After the First Occurrence (Question 6–5 see Appendix)*

The Developmental Steps of Normalization

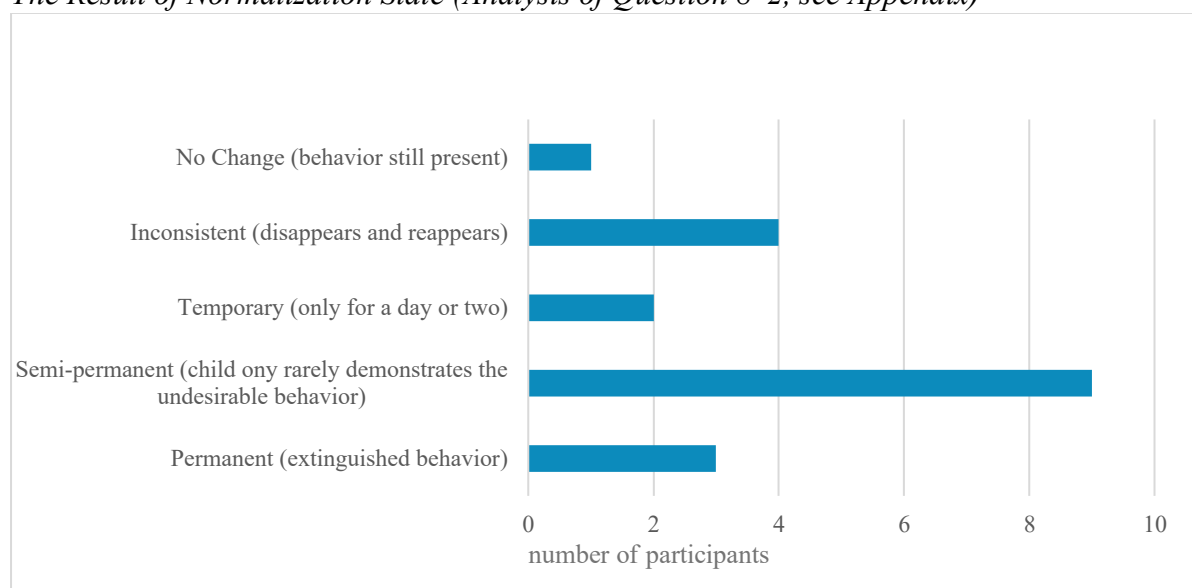
Based on teachers' observations, the process of Normalization followed a relatively consistent sequence across cases:

1. The child freely chooses an activity of genuine interest.
2. The child demonstrates unusually deep and sustained concentration.
3. Feelings of joy, satisfaction, calmness, and inner order emerge.
4. These experiences recur with increasing frequency.
5. The child enters a semi-permanent or permanent normalized state.

This sequence closely mirrors Montessori's original descriptions while providing greater empirical specificity regarding frequency and duration. The data suggest that Normalization is not a single event but a developmental trajectory, marked by repeated experiences of concentrated engagement.

Stability of Normalization: Semi-permanent and Permanent States

Another significant finding concerns the durability of Normalization. The majority of teachers reported that once Normalization occurred, 68% of children remained in a normalized state either semi-permanently or permanently. Behavior problems were largely reduced or eliminated, particularly those related to impulsivity, aggression, and lack of self-regulation.

Figure 4*The Result of Normalization State (Analysis of Question 8–2, see Appendix)*

Although some children initially exhibited inconsistent or temporary changes, these cases were often described as being in an early or incomplete phase of the Normalization process. Overall, the findings suggest that Normalization, once established through repeated experiences, has a lasting stabilizing effect on children's behavior and emotional regulation.

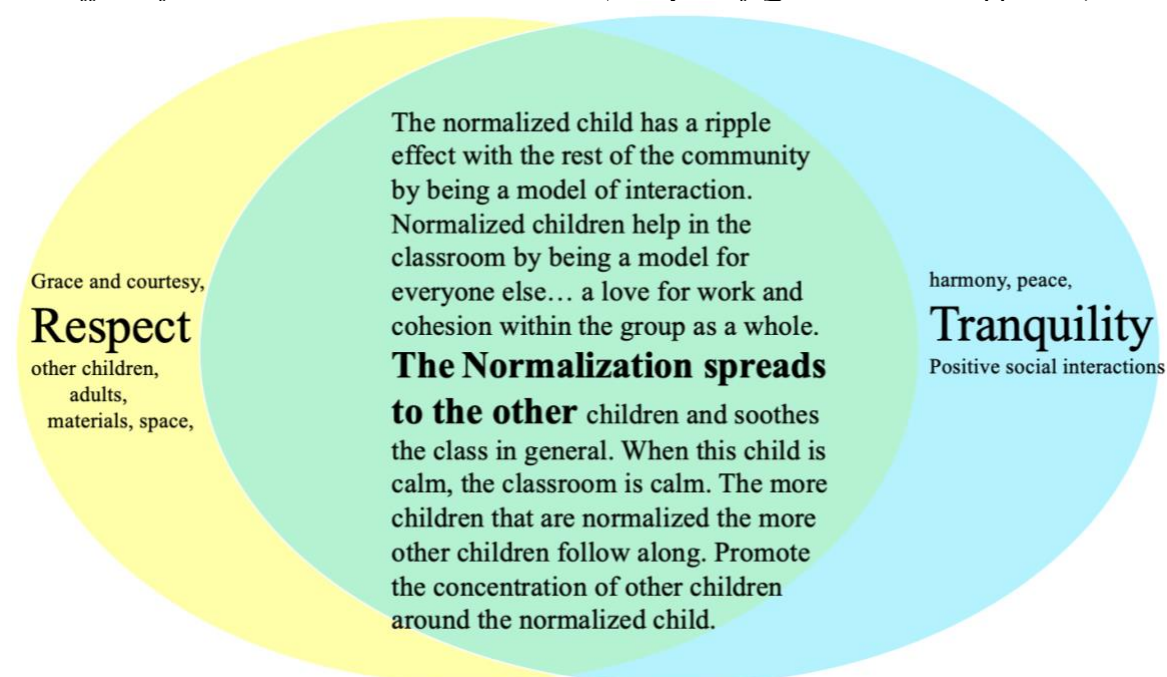
This observation addresses a gap in Montessori's original writings, which emphasized the occurrence of Normalization but offered limited discussion of its long-term stability. The present findings provide empirical support for the claim that Normalization can function as a durable developmental outcome rather than a transient state.

Finding 2: From Individual Normalization to Classroom Peacefulness

The second major finding concerns the relationship between Normalization and peace education. Teachers predominantly described peacefulness as a direct outcome of Normalization, both at the individual and classroom levels. Normalized children were characterized as calm, respectful, socially engaged, and considerate of others.

Importantly, many respondents emphasized that the effects of Normalization were not confined to individual children. Instead, they described a clear ripple effect in which normalized children influenced their peers and contributed to a more harmonious classroom atmosphere (Figure 5). This process occurred through modeling behavior, respecting shared norms, and supporting peers, rather than through explicit instruction.

The classroom was frequently described as a "small society," suggesting that the peacefulness cultivated within the Montessori environment serves as a microcosm of broader social relations. This finding empirically supports Montessori's assertion that peace education begins with individual inner order and extends outward to the community.

Figure 5*The Effect of Normalization in the Classroom (Analysis of Question 9, see Appendix)*

Note. This Venn Diagram captures 14 qualitative responses out of 15 for question nine.

Reproduction of Peace Beyond the Classroom

Most participants (95%) expressed confidence that the peacefulness observed in Montessori classrooms could be reproduced in broader social contexts, including schools and communities beyond early childhood settings. While some acknowledged that societal environments are less controlled than classrooms, many emphasized that children who are normalized carry internalized self-regulation and ethical orientation into new contexts.

Several teachers provided examples of Montessori graduates maintaining prosocial behavior even when entering non-Montessori educational systems. Although these children may represent a minority, their actions—such as supporting peers and resisting aggressive norms—were described as meaningful contributions to social harmony.

These observations suggest that Normalization may function as a foundational mechanism linking early childhood education to long-term peace education outcomes.

Explicit Answers to the Research Questions

In response to the first research question, the findings demonstrate that Normalization occurs internationally under similar conditions, is most reliably triggered by children's spontaneous choice of work, and typically develops gradually over several years rather than instantaneously.

Regarding the second research question, the data provide strong evidence that Normalization contributes to peace at both the individual and community levels, with normalized children fostering peaceful classroom environments through sustained self-regulation and social responsibility.

Summary

In summary, this study examined the occurrence and characteristics of Normalization in early childhood Montessori settings based on teachers' observations across multiple cultural contexts. The findings indicate that Normalization is closely associated with heightened and sustained concentration and tends to recur over time, although with considerable individual variation in duration and frequency. These results suggest that Normalization functions as a meaningful developmental process with implications extending beyond individual behavior management to peace education more broadly. Together, the findings underscore the relevance of Normalization for understanding how peaceful classroom environments are fostered, providing a foundation for the recommendations presented in the following section.

Recommendations

Based on the findings of this exploratory international study, several recommendations can be made for educational practice, teacher education, and future research in the field of peace education.

First, for educational practice, the results suggest that peace education in early childhood should prioritize developmental conditions rather than explicit moral instruction. Teachers are encouraged to focus on creating and maintaining a prepared environment that allows children sustained freedom of choice and opportunities for deep concentration. The finding that Normalization is most often triggered by children's spontaneous choice of work indicates that peaceful classroom communities emerge gradually through daily practice, patience, and careful observation, rather than through externally imposed behavioral interventions.

Second, for teacher education and professional development, training programs should emphasize Normalization as an observable developmental process rather than an abstract theoretical concept. Helping teachers recognize early signs of concentration, self-discipline, and social harmony may strengthen their ability to support Normalization and foster peaceful classroom dynamics across diverse cultural contexts.

Finally, the findings indicate that Normalization is a powerful developmental process whose implications extend beyond individual behavior management to peace education more broadly. To further clarify this relationship, future research should employ longitudinal and mixed-method designs, incorporating classroom observations, child-centered data, and larger samples across diverse cultural contexts. Such approaches would deepen understanding of how Normalization can be consistently and sustainably supported, as well as identify factors that may interrupt or delay the process, thereby refining Montessori's original claims in light of contemporary educational practice.

Conclusion

This study examined how and when Normalization occurs in Montessori settings for children from birth to six years old and whether it contributes to peace within a community. The findings demonstrate that Normalization is most effectively triggered when children freely choose activities aligned with their intrinsic interests, leading to deep concentration. Contrary to Montessori's early descriptions of sudden and miraculous transformation, the results indicate that Normalization more commonly emerges gradually through repeated experiences of concentrated work. Once initiated, Normalization tended to become semi-permanent or

permanent for most children, and approximately 95% of participants reported that behavioral challenges were addressed through this process. Importantly, the study provides empirical support for the ripple effect of Normalization: the inner calm and self-regulation of one child positively influenced peers, fostering a peaceful classroom community that teachers believed could extend into broader society. These findings reaffirm Normalization as the core mechanism through which Montessori education functions as peace education, supporting Montessori's assertion that "Normalization is the single most important result of our work" (Montessori, 1949, p. 204).

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

Grammarly was used only for proofreading and language refinement. No AI or AI-assisted technologies were used to generate the content or findings of this study.

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Appendix

Survey Questions

1.In which city and country is your school?
2.Are you a credentialed Montessori teacher? (Yes/ No) If no, please skip to question 4. If yes, please answer question 3.
3.Select which level(s) you hold a credential: 0-3, 3-6
4.From where did you earn your credential? (AMI, AMS, Other → write in)
5.Are you familiar with the Montessori concept of Normalization?
6-1.How was the child deviated/ or what was the deviation?
6-2.Where was the child; what were they doing when Normalization happened?
6-3.When the child demonstrated Normalization, how long did it continue?
6-4.How often did you see the child exhibit Normalization subsequent to the first time?
6-5.If you were to compare the deviated (unnormalized) child to the normalized child, how would you characterize the results of Normalization?
7.In a class of 25-30 students, how many children on average undergo a Normalization process in your experience?
8.Have you witnessed behavior problems being addressed through Normalization?
8-1.If so, what was / were the behavior(s)? How were the behavior problems improved?
8-2.What was the result of the Normalization on the behavior?
9.How would you characterize the effect of a Normalized child/ children on a classroom community? (Consider classroom atmosphere before and after such as peacefulness, respect, engagement, social interactions, etc.)
10.What is the relation between Normalization and peacefulness in the classroom?
11.Do you think that peacefulness exhibited in a classroom could be reproduced in society?
11-1.Please expand on your response.
12.Do you think Normalization can happen in a regular household?
12-1.Please expand on your response.
13.Please feel free to share any further comments, stories, or experiences about Normalization.

Linking Context to Concept: How Different Types of Context Shape Grade 9 Mathematics Learning

Nel Maboko, North-West University, South Africa

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Abstract

This study explores how different types of contexts influence the learning of mathematics in a Grade 9 classroom. Framed within situated learning theory and the constructs of affordances and constraints, the research explores how various contextual approaches, namely, familiar, real, extended, contrived, and contexts of the discipline, shape learners' engagement with mathematical concepts. Employing a qualitative teaching experiment design, the researcher assumed a dual role as teacher and observer, using purposive sampling to focus on nine learners. Data were collected through video-recorded classroom interactions and analysed using narrative and retrospective techniques. Findings reveal that context significantly influences how learners interpret and approach mathematical problems. While certain contexts enhance participation, understanding, and problem-solving strategies, others introduce barriers, such as linguistic complexity or unfamiliar references, that distract from conceptual comprehension. Notably, learners often struggled more with interpreting the context than with the mathematical tasks themselves. The study underscores the importance of deliberate context selection in instructional design and highlights how aligning context with learners' experiences can facilitate deeper mathematical understanding.

Keywords: contextual teaching, situated learning, affordances, constraints, attunements

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Introduction

Learners' persistent underperformance in mathematics, particularly in the General Education and Training (GET) band in South Africa, remains a concern for educators and researchers (Makofane et al., 2025). To address this challenge, educators and researchers have proposed various instructional approaches, and the literature highlights contextual teaching as a noteworthy option. Context seeks to connect mathematical concepts to situations, problems, or experiences that are meaningful to learners, thereby enhancing their understanding and engagement (Anugraheni et al., 2025; Laughbaum, 2001).

Research suggests that teaching using context can make mathematics more accessible and meaningful by linking abstract concepts to learners' lived experiences (Selvianiresa & Prabawanto, 2017; Williams, 2007). However, studies have also indicated that the use of context may pose challenges, such as linguistic complexity, unfamiliar references, and misalignment between the context and the mathematical concept (Barnes & Venter, 2008). Importantly, much of the existing literature has relied on written assessments (Bansilal & Debba, 2012; Kappassova et al., 2025) or teacher reports rather than examining classroom interactions in natural teaching settings, of which learners' real-time sense-making, participation, and interpretation of contextual tasks remain under-explored.

This article draws on the author's master's dissertation to examine how contextual teaching may afford or constrain mathematics learning. Therefore, different types of contexts were employed to shape mathematics learning in a Grade 9 mathematics classroom, where learners' participation and meaning-making were the center of attention.

Literature Review

Conceptual Nature of Context and Its Types in Mathematics

Defining context in mathematics education is complex because the term encompasses a range of meanings and purposes (Brown, 2019). Rather than offering a single definition, researchers have proposed classifications of context that are useful for instructional design. This study understands context as a situation used to enhance the teaching and learning of mathematics (Laughbaum, 2001).

Building on Metz's (2013) model of contextual understanding, five types of contexts are central to this study: familiar, real, extended, contrived, and context of the discipline. Familiar contexts draw on learners' everyday experiences and interests; real contexts involve authentic situations that can be directly experienced; extended contexts integrate mathematics with broader social, cultural, or scientific issues; contrived contexts are fictional scenarios designed to highlight specific mathematical ideas; and the context of the discipline situates learning within abstract mathematical structures and relationships (Metz, 2013).

Linking Context to Mathematics Learning

Context has long been recognised as a powerful influence in mathematics learning, shaping not only what learners attend to, but how they interpret and engage with mathematical concepts (MacDonald, 2022). Research echoes that contextualisation in mathematics, particularly when it draws on learners' real-world experiences and cultural backgrounds can make abstract mathematical concepts meaningful and accessible (Luneta, 2023). Research on

culturally responsive assessment further supports this, showing that culturally familiar contexts embedded in mathematical word problems can significantly improve learners' performance, engagement, and confidence because they reduce unnecessary cognitive load and link mathematics to students' lived experiences (Ntumi et al., 2026).

Contextual Teaching in Mathematics

Contextual teaching is regarded as an approach that actively involves learners in constructing mathematical knowledge through engagement with meaningful situations (Selvianiresa & Prabawanto, 2017). By encouraging discussion, interpretation, and problem-solving, contextual teaching promotes learner participation and mathematical communication (Brown & Redmond, 2017). However, the effectiveness of contextual teaching depends on the nature of the context used and learners' ability to interpret it appropriately (Mahmuti et al., 2025).

Yasin et al. (2023) allude that while context can stimulate interest and provide cognitive support, it may also divert learners' attention away from the mathematical goal, particularly when the language or scenario is unfamiliar. This dual nature of context underscores the need to examine both its affordances and constraints within actual classroom interactions.

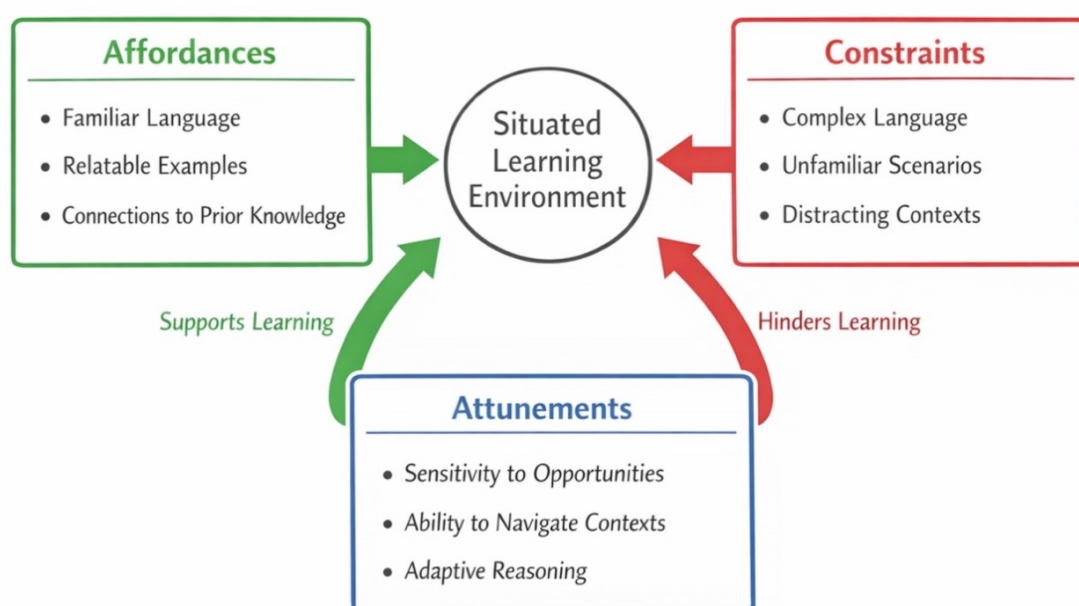
Theoretical Framework

This study is theoretically framed by situated learning as set out by Greeno (1998). Situated learning theory offers a useful framework for understanding how learners engage with mathematical contexts in classrooms. According to Greeno (1998), learning is inherently situated and occurs through interactions with the environment, tasks, and social processes. Within this perspective, three constructs affordances, constraints, and attunements help explain how contexts can either afford or hinder learning.

Situated Learning, Affordances, Constraints, and Attunements in Mathematics Contexts

Figure 1.1

Situated Learning Model



Affordances are opportunities within a learning environment that enable meaningful action (Greeno, 1998). In mathematics classrooms, these include familiar language, relatable examples, and links to prior knowledge that support reasoning and problem-solving. Contexts grounded in learners' experiences and culture can enhance engagement and understanding.

Conversely, constraints are features that limit interpretation or action, such as complex language, unfamiliar scenarios, or distracting details. The study found that contrived or extended contexts sometimes hindered learning by adding cognitive demands or disconnecting from learners' experiences.

Attunements describe learners' ability to perceive and use available affordances while managing constraints. In the Grade 9 classroom studied, learners often struggled more with interpreting contextual features than with the mathematics itself. This framework highlights how context type and learner attunement interact to shape mathematics learning and underscores the importance of accessible context design and appropriate scaffolding.

Methodology

Research Design and Approach

This study adopted a qualitative research approach within a constructivist paradigm, recognizing learning as a social construct through interaction (Guba & Lincoln, 1994). A teaching experiment design was employed, enabling the researcher to investigate learners' mathematical thinking as it developed during teaching and learning (Steffe & Thompson, 2000).

Participants and Data Generation

Purposive sampling was used to select nine learners from a Grade 9 mathematics class for an in-depth analysis. These learners participated in a series of teaching experiments in which different types of contexts were used. Data were generated through video recordings of classroom interactions, capturing both verbal and nonverbal participation, as recommended for teaching experiments (Steffe & Thompson, 2000).

Data Analysis

Data were analyzed retrospectively using narrative analysis, which involved rewriting classroom interactions as analytic stories to identify patterns of participation and meaning making (Polkinghorne, 1995). Greeno's (1998) constructs of affordances, constraints, and attunements within situated learning theory guided the interpretation of learners' interactions in this study.

Summary of Results

This section provides a concise narrative summary of the results of the teaching experiments, while retaining most of the tables and figures from the original document. Samples of this information are presented. This section frames the analysis within situated learning theory, focusing on affordances, constraints, and learner attunement (Greeno, 1998).

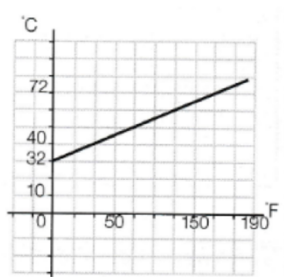
Teaching Experiment 1: Extended Context

In this teaching experiment, the extended context was adopted to teach functions and relationships. For the purpose of reporting, an excerpt from one of the groups, which consists of my target participants, was captured. Below is an activity, which is then followed by an excerpt from the group discussions.

Figure 1.2

Learning Activity

A chef uses a recipe from the UK. Use the equations $F = \frac{9C}{5} + 32$, that converts degrees Fahrenheit to degrees Celsius, to determine how many degrees Celsius are equal to:



a.) 150°F

b.) 50°F

c.) 190°F

How many degrees Fahrenheit are equal to:

d.) 40°C

e.) 72°C

f.) -18°C

Learners were observed in a discussion on their approach to solving the first activity. The following excerpt is from my target participants Tebatso (female), Ngoako (male), Chegofatso (male), Mohlago (female) and John (male). They were observed during the discussion of the learning activity. I then started initiating the discussion regarding the activity.

Excerpt: 1

1.1 Teacher: Let's hear how you will work out the problems.

Out of excitement, Tebatso answers the question before everyone else does.

1.2 Tebatso: Sir, here we are going to use the equation that we have in order to convert Celsius to Fahrenheit.

Ngoako further explained the details of how they were solving the equation, and now that I realized that they have an idea of what to do in a.), b.) and c.).

1.3 Ngoako: In so doing that we will replace the F by 50 in the given formula.

Ngoako started doing the calculation in his book to show the rest of the group members how it should be done.

Figure 1.3

Ngoako's Attempt

$$\begin{aligned}
 & 50 = 9C + 32 \\
 & 50 - 32 = \frac{9C}{5} \\
 & 18 = \frac{9C}{5} \\
 & 9C = 18 \times 5 \\
 & \frac{9C}{9} = \frac{90}{9} \\
 & C = 10
 \end{aligned}$$

1.4 Teacher: Then how will you go about answering d.), e.) and f.)?

1.5 Tebatso: We also are going to substitute F, by 40, 72 and -18 degrees Celsius.

Tebatso then gave an input as to how the problem that required them to convert degrees Fahrenheit to Celsius should be approached. However, Chegofatso (in line 1.6) noticed that the temperatures in problem d.), e.) and f.) were already expressed in Celsius.

1.6 Chegofatso: but here in d.), e.) and f.) They are already in Celsius.

1.7 Tebatso: Why do you say so? Am confused.

1.8 Ngoako: I also don't understand.

Even Ngoako was confused. However, Chegofatso notice that d.), e.) and f.) had to be done differently. Then he started writing d.) as a collaborative effort with Ngoako, although Chegofatso was the one doing the writing and managed to do substitutions in order to obtain the final answer. However, the formula was not used correctly as: $F = 9C/5 + 32$, the number "5" was missing, but Ngoako included it when he came up with the answer.

Figure 1.4

Chegofatso's Attempt

$$\begin{aligned}
 & 40^{\circ}C \\
 & F = 9C(AD) + 32 \\
 & F = 104
 \end{aligned}$$

1.9 Chegofatso: look at the units, they are in degrees Celsius, and the question says: 'how many degrees Fahrenheit?'

After discussing their approaches, learners completed the activity and produced consolidated solutions. The focus was to analyse how they interpreted the scenario to identify contextual affordances and constraints. The extended scientific context supported connections between mathematics and science, and learners showed procedural competence in substitution and

formula use. However, some learners misinterpreted contextual language and struggled with unit conversions, which limited their understanding and highlighted constraints within the context.

Teaching Experiment 2: Familiar Context (Application of a Rule)

In this teaching experiment, learners applied a rule or equation within a familiar context. Using relatable terms such as fashion, fabrics, cost, and money helped align the activity with learners' experiences and interests, making the concept of applying a rule more accessible and engaging.

Figure 1.5

Learning Activity

A fashion designer buys fabric online from an overseas supplier. The total cost in rands including postage depends on the length, x metres of fabric purchased, where $c = 120x + 50$.

a) Complete the table

x (metres)	1	2	3	4	5
Cost (rands)					

b) How much would it cost the fashion designer if she bought $7\frac{1}{2}$ metres of fabric?

c) The fashion designer paid R1130. How much fabric did she buy?

Figure 1.6 below represents the consolidated responses from the target group. The discussions on how they went about consolidating their responses are provided, and one member of the group was asked to write down the ideas and responses as the activity unfolded. An excerpt is provided to highlight the discussions at play.

Figure 1.6
Consolidated Response

Classwork
Pig 203
12 (a,b,c)
Rule: $C = 120x + 50$
Group 3 28 August 2020

x (metres)	1	2	3	4	5
Cost (rand)	170	290	410	530	650

12 (a) $C = 120x + 50$
 $C = 120(7.5) + 50$
 $C = 950$

12 (b) $C = 120x + 50$
 $C = 120(9) + 50$
 $C = 1130$

$\therefore x = 9$
 $C = 120x + 50$
 $1130 = 120x + 50$
 $x = 9$

The excerpt below presents the deliberations that took place during the group discussion between; Tumelo (male), Dioka (female), Lethabo (Female) and Malope (male). Prior to the discussions, I encouraged learners to participate and feel free to raise their inputs.

Excerpt: 3

- 3.1 Teacher: From the way you understand the scenario given, what does the x and the c on the formula represent?

Tumelo is one of the talkative learners in my class, he is always overconfident in giving out answers, irrespective of whether the answers are correct or not. He always wants to outshine his fellow learners whenever there is an opportunity to do so. He was the first one to participate, as he was the first to answer the question that I just asked.

- 3.2 Tumelo: x represents metres and c represents the cost or rands.

I asked the rest of the group members if they agreed with Tumelo's response, and they all confirmed that they did, and therefore confirmed that indeed his response is correct. Thereafter, I posed a follow-up question (in line 3.3) to the learners.

- 3.3 Teacher: So now in a.) you are required to complete the given table. How are you going to complete the table?
- 3.4 Dioka: We are going to use the given formula.
- 3.5 Teacher: How do you use the formula?
- 3.6 Lethabo: We are going to take the values of x as they are given on the table, then we shall substitute them in the given formula.

After the deliberations with Lethabo, I then requested the group to fill in the answers in the table in a.). I observed them as they discussed the activity and Dioka suggested to the rest of the group that they use a calculator to obtain the answers without showing the workings on how they arrived at the answers. The answers were then presented in Figure 4.6 below.

Figure 1.7
Lethabo's Attempt

Rule: $C = 120x + 50$

2 metres	1	2	3	4	5
Cost rands	170	290	410	530	650

3.7 Teacher: Is there any other approach you used to complete the rest of the questions?

The rest of the group members were listening to the deliberations between me, Lethabo and Dioka (in lines 3.3–3.6) and they worked as a group to complete a.). Thereafter, I asked them a question about a different approach to the one Dioka presented (in line 3.7) and they all answered “no”.

3.8 Teacher: Ok then, let's discuss b.), anyone to help us with an explanation?

3.9 Tumelo: Sir, I think we should use the same formula to calculate the cost of seven and half mitres of fabric, and we are going to substitute 7,5 into the formula.

3.10 Teacher: Okay then, can you now write the response to b.).

When responding to the second problem in b.), Tumelo suggested to the rest of the group that they should only write down the answer. I then intervened and requested them to show all the steps they took when they calculated the answer. My reason for requesting them to show the whole calculation was that I needed to see how they would substitute 7,5. Dioka suggested that they change 7.5 into 7.5. Ultimately, they agreed on the answer in Figure 4.7 below. Furthermore, I requested them to also complete the last question c.).

Figure 1.8
Consolidated Response

$$\begin{aligned}
 c) \quad C &= 120x + 50 \\
 &= 120(7.5) + 50 \\
 &= 950.
 \end{aligned}$$

3.11 Teacher: Ok then, take me through to how you solved c.).

3.12 Dioka: For question c.), we looked for all the terms and we found it to be term number 9.

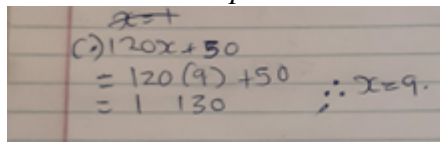
The response provided by Dioka (in line 3.12) is a clear indication that they adopted a trial-and-error strategy to answer the last question c.). Dioka's explanation was supported by Tumelo (in line 3.13), as he deliberated on how they verified whether their answer to c.) was correct or not.

3.13 Tumelo: We then substituted 9 in to the formula, so that we get the answer that we want.

Figure 4.8 below illustrates the consolidated response to the last question c.) of the activity. Although the formula was not written correctly and the solution does not show exactly how they arrived at an answer of “9”, they still managed to obtain the correct answer, which is 9.

Figure 1.9

Consolidated Response



Handwritten work on lined paper:

$$\begin{aligned} & \text{c) } 120x + 50 \\ & = 120(9) + 50 \\ & = 1130 \end{aligned} \quad \therefore x = 9$$

- 3.14 Teacher: Oh, so you did not use the formula? What is this 9? Cost or length of fabric?
- 3.15 Dioka: It is the length (x) in metres
- 3.16 Lethabo: We only used the formula to check if 9 is the length equivalent to a cost of R1130. So, that means we substitute 9 as the length into the formula, so that we get an answer of R1130.

Lethabo was not actively participating during the discussions. She was only observed to agree with everyone's answer. Ultimately, she supported the ideas presented by Tumelo.

- 3.17 Teacher: Okay I see, I was not expecting that approach. I was hoping you would substitute that amount of R1130 into the given formula so that you can calculate x.

Familiar contexts related to everyday experiences, such as fashion and medicine, increased learner engagement and participation. Learners were able to interpret variables meaningfully and apply given rules, suggesting strong affordances for sense-making (Selvianiresa & Prabawanto, 2017). Nonetheless, some learners relied on trial-and-error strategies or struggled to decontextualise problems, indicating that familiarity alone does not eliminate conceptual constraints.

Teaching Experiment 3: Contrived Context (Writing Algebraic Expressions)

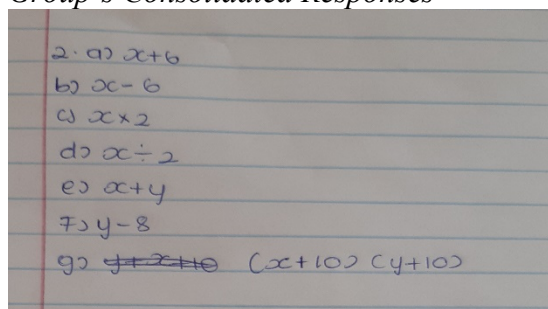
In this teaching experiment, learners engaged in an activity based on a contrived context using familiar words, events, and real names to mimic reality. The purpose was to assess their ability to write mathematical expressions. A narrative of the teaching episode describes how learners discussed the activity in groups to explore and represent the intended mathematical ideas.

Figure 1.10*Learning Activity*

Thabo is x years old and Lizzie is y years old.
Write down algebraic expressions for:

- a.) Thabo's age in 6 years' time
- b.) Thabo's age in 6 years ago
- c.) Thabo's age doubled
- d.) Half Thabo's age
- e.) The sum of Thabo and Lizzie's ages
- f.) Lizzie's age 8 years ago
- g.) The sum of Thabo's and Lizzie's age in 10 years' time

Presented below are the sampled learners' responses to Activity 5. The responses are followed by a narrative of what the teacher and the learners were saying and writing during the activity. In the narrative, excerpts from the group discussions were also captured as part of the narrative. The following excerpt is from a group of learners consisting of Ngoako, Mohlago, Tebatso, Chegofatso and John. Figure 4.12 shows the answers that the group agreed upon after their discussion and the interactions between the learners during their discussion of the answers are captured in the excerpt below.

Figure 1.11*Group's Consolidated Responses***Excerpt: 5**

In this excerpt, I listened to and observed the learners as they discussed their answers to different questions. Ngoako was the first learner to attempt to answer the first question (in line 5.1), followed by the other participants. In this excerpt, I did not state whether the learners' responses were correct or not, all I did was to ask questions about how they approach the problems.

- 5.1 Ngoako: The answer for a.) is $x + 6$
 5.2 Teacher: Why do you say so?

Ngoako could not account for the answer that he gave, however, Tebatso came to his rescue and attempted to respond (in line 5.3), while Ngoako and other members of the group were quiet and listening.

- 5.3 Tebatso: Thabo's age in 6 years' time means that we add.
 5.4 Teacher: Oh! Okay?
 5.5 John: It is the same as when they say in the future.
 5.6 Teacher: Do you all agree that the answer is $x + 6$?

After Tebatso has explained, John then started supporting Tebatso's response (in line 5.5) and thereafter I asked all members of the group if they concurred with the response to the first problem in a.). They all said "yes".

- 5.7 Teacher: ... and what will be the answer for b.)?
 5.8 Chegofatso: Sir, the answer is $6-x$, because in 2.a) the answer was $6-x$, so this time *ree busetsa morago* (meaning that we are taking it back).
 5.9 Ngoako: No, but this time we are going to subtract 6 from x if we have to write an expression for his age six year ago. Therefore, the answer should be $x-6$.

Chegofatso's response to the second problem (in line 5.8) indicates that she is guessing answers instead of giving out well thought of responses. However, Ngoako came in and addressed Chegofatso's misconception regarding the answer for b.). There, after, Mohlago, John and Tebatso supported that Ngoako's answer is the correct one.

- 5.11 Teacher: What about the answer for c.)?
 5.12 Mohlago: Thabo's age doubled can be expressed as x multiply by 2
 5.13 Chegofatso: I suggest the answer to be x multiply by 6.

This time, Mohlago is the learner who provided the answer for c.) and Chegofatso felt that he also had an answer, which was different from the one given by Mohlago. However, Ngoako also shared his answer (in line 5.14), which was unfortunately also not the correct one. Ultimately, Tebatso seemed to have an idea of what was required to solve this problem (in line 5.15) and, as a result, Ngoako now agreed with him (in line 5.16).

- 5.14 Ngoako: No, the statement implies that his age is doubled, meaning that the answer is 6 times 6.
 5.15 Tebatso: But when you double you multiply by 2, not 6 multiply by 6.
 5.16 Ngoako: Oh okay I get you, that means the answer should be 6 times 2.

The discussions now seemed to become interesting, and I then asked a question (in line 5.17), in order to make the learners aware of how they should write their answer down. On that note, Mohlago was already aware that they should include the variable x when they answer the problem (in line 5.18). As a result, learner ended up agreeing that the answer should be x multiply by 2.

- 5.17 Teacher: But from the statement Thabo's age is x . Why is your expression not containing x ?
- 5.18 Mohlago: Sir, that is why I said x multiply by 2, which means that Thabo's age is doubled.
- 5.19 Ngoako: Hhmm! Okay I see.
- 5.20 Teacher: So do you all agree with the answer?

While learners were still excited about the answer for b.), Chegofatso was now so excited and she could not wait and jumped to the next problem in d.) (in line 5.21). All members of the groups answered simultaneously and said "yes" to Chegofatso's answer. Following, Chegofatso's response, Mohlago and Ngoako could not wait, and they also gave answers for e.) and f.) (in line 5.23–5.25).

- 5.21 Chegofatso: So, now it means the answer for d.) we divide Thabo's age by 2, because we want half of his age
- 5.22 Mohlago: Then it means we express it as x divide by 2.
- 5.23 Ngoako: Then for number e.), the sum of Thabo and Lizzie's age we write $x + y$, because when they say sum, we plus (+).
- 5.24 Mohlago: So for f.) the answer will be $y - 8$, *e swana le ka mokgwa o re arabileng b.)* (meaning that the answer can be found using the same method we used in b.) above.

At this stage, learners were participating and giving each other a chance to raise their views with regard to the answers.

- 5.25 Ngoako: The answer for g.) is $x + y + 10$, because the sum of Thabo and Lizzie's age will be added by 10 years.
- 5.26 Tebatso: But I think the answer should be $(x + 10)(y + 10)$
- 5.27 Ngoako: No, your expression has brackets, which implies that you multiply, and we should add because the statement said the 'sum'.
- 5.28 Chegofatso: *Eish*, this is confusing for me

Now that I realised that learners were stuck when trying to respond to the pervious problem, I saw the need to intervene. I then decided to help the learners by using the answer Tebatso gave (in line 5.26), by emphasizing that there should be an addition sign when writing the response: $(x + 10) + (y + 10)$.

From the narrative above, the contrived context supported collaborative learning and peer explanation when writing algebraic expressions. Learners benefited from group discussions, which helped resolve misconceptions and attune learners to mathematical meanings embedded in language (Boaler, 1999). However, contextual wording sometimes led to confusion, especially with terms such as "sum", "double", and "half", highlighting language as a recurring constraint (Barnes & Venter, 2008).

Teaching Experiment 4: Context of the Discipline (Algebraic Equations)

In this teaching experiment, the learners were provided with learning activities that were based on the context of the discipline. In this type of context, mathematical concepts are not aligned to a situation outside the mathematics domain, they comprise abstract mathematical

problems (Metz, 2013). Metz (2013) suggested that educators should look for contexts that are central to mathematical concepts.

Figure 1.12

Learning Activity

Solve for x

a.) $2x + 6 = 0$

b.) $\frac{2x-1}{3} + x + 2 = 0$

c.) $(x + 4)(x - 4) = 0$

d.) $x^2 + x - 6 = 0$

Learners Mohlago (female), Chegofatso (male), Ngoako (male) and John (male) started the discussions, which are captured in the excerpt below.

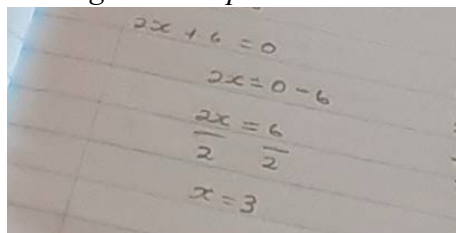
Excerpt: 7

- 7.1 Teacher: Okay, can you deliberate on the activity and come up with solutions.
- 7.2 Mohlago: the first one is easy let's start from b.).
- 7.3 Teacher: No, let's start from a.) not b.), because it might not be easy for everyone. And since well you are saying it is easy, take us through a.).
- 7.3 Mohlago: Oh, okay sir.

Then Mohlago started doing the calculations, while the other members of the group observed him. Figure 1.13 below shows her solution to a.).

Figure 1.13

Mohlago's Attempt



Handwritten solution for $2x + 6 = 0$:

$$2x + 6 = 0$$

$$2x = 0 - 6$$

$$2x = -6$$

$$\frac{2x}{2} = \frac{-6}{2}$$

$$x = -3$$

7.4 Chegofatso: Sir, can I say something.

7.5 Teacher: Yes say it. And please feel free to participate.

- 7.6 Chegofatso: I think Mohlago's answer from 0 - 6 should be - 6 in the next step, which means that the final answer should be - 3.
- 7.7 Mohlago: Oh yes, I just forgot that.
- 7.8 Teacher: Okay Mohlago, do you see that it is not easy? The other group members, together with Mohlago laughed.
- 7.9 Ngoako: Ok can I please do problem b.).

Ngoako offered to do the next problem, and his attempt is illustrated in Figure 1.14 below. He realised that he needed to simplify the equation by firstly eliminating the denominator of 3 in $(3x-1)/3$. However, was puzzled by the step where he had to add like terms, which is something I thought should be easy to do. I then requested the members of the group to assist him and John came in with a solution.

Figure 1.14

Ngoako's Attempt

Handwritten work on lined paper showing the attempt to solve an equation. The work includes the following steps:

$$\frac{3x-1}{3}$$

$$3 \times \frac{3x-1}{3} + 2 + 2 = 0$$

$$3x-1+3x+2x+3=0 \times 3$$

$$22-1+3x+6=0$$

- 7.10 John: Sir, I think $2x$ and $3x$ are like terms and we add them to give us $5x$.
- 7.11 Tebatso: Yes, John is right, and that makes -1 and $+6$ also like terms.

Tebatso attempted to finish the problem that Ngoako started by writing $5x + 5 = 0$. Thereafter, Mohlago requested to take over the problem solving when she realised that the step written by Tebatso was similar to the first problem in a.)

- 7.12 Mohlago: Tebatso please let me finish it.

Tebatso let Mohlago to take over and finished the answer by writing $5x = -5$, followed by $5x/5 = -5/5$, and she wrote an answer of $x = -1$. This shows that Mohlago had learnt from the mistake she committed when attempting to solve the first problem in a.).

- 7.13 John: Sir on the next problem in c.) I think the answers are $x = 4$ and $x = -4$.

In fact, John had completed this problem, which other members of the group were still focussed on b.). He found it an easy target. From John's answers he was able elaborated that, in the first step, one should write $x + 4 = 0$ or $x - 4 = 0$ and, thus, $x = 4$ or $x = -4$ As a result, all members of the group confirmed that they were satisfied about his efforts.

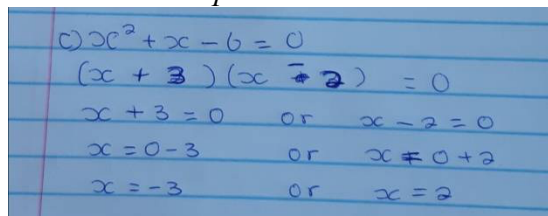
- 7.14 Mohlago: Tebatso can you please do the last one if you don't mind.
- 7.15 Tebatso: Okay, I am not sure about the last one. Sir, please intervene.

I then asked whether there is anyone who wanted to try it. Unfortunately, the learners confirmed that they were challenged by this problem. This is an indication that they were constrained towards solving the problem. I then explained to the learners that they needed to

factorise first. The explanation served as an attunement of the constraint that had made learners not able to participate. Suddenly, Tebatso offered to proceed with solving the problem; her attempt is depicted in Figure 1.15 below. Thereafter, the members of the group confirmed that they were following what he had written, because the steps written by Tebatso when she was solving the problem were similar to the steps in the previous problem in c.).

Figure 1.15

Tebatso's Attempt



Handwritten mathematical work on lined paper showing the factorization of a quadratic equation. The work is as follows:

$$\begin{aligned}
 &0x^2 + x - 6 = 0 \\
 &(x + 3)(x - 2) = 0 \\
 &x + 3 = 0 \quad \text{or} \quad x - 2 = 0 \\
 &x = 0 - 3 \quad \text{or} \quad x = 0 + 2 \\
 &x = -3 \quad \text{or} \quad x = 2
 \end{aligned}$$

When problems were presented purely within the mathematical domain, learners relied on established algebraic procedures. Participation and peer correction indicated that the disciplinary context afforded access to core mathematical practices such as simplification and factorisation. Teacher intervention played a key role in attuning learners to overlooked strategies, thereby reducing constraints (Boaler, 1999).

Findings and Discussion

The findings indicate that the type of context plays a crucial role in shaping learners' interpretation and engagement with mathematical problems. This concurs with a study by MacDonald (2022), as they allude that context shapes how learners interpret and engage with mathematical concepts. Contexts that were familiar or drawn from learners' everyday experiences tended to enhance participation, promote collaborative discussion, and support problem-solving strategies (Brown & Redmond, 2017). In contrast, extended contexts encourage broader reasoning but occasionally introduce cognitive overload, making it difficult for learners to identify the core mathematical focus.

Contrived contexts effectively illustrate targeted mathematical concepts but sometimes limit engagement when learners question their relevance. Contexts closely tied to disciplinary norms promote formal mathematical reasoning but offer fewer accessible entry points for learners dependent on concrete contextual cues. Across all types, a consistent challenge emerged: learners often struggled more with interpreting contextual information than with solving the mathematical tasks themselves (Mahmuti et al., 2025).

These findings highlight the significance of carefully selecting the context for instructional design. Aligning context with learners' prior knowledge and experiences can facilitate a deeper understanding, whereas mismatched or overly complex contexts may distract from conceptual comprehension. Overall, context functions as both an affordance and a constraint in mathematics learning, shaping not only engagement but also the strategies that learners employ to approach problems.

Conclusion

This study shows that context significantly influences Grade 9 mathematics learning, both supporting and constraining learners' engagement and understanding. While contextual

teaching can enhance participation and meaning-making, its effectiveness depends on careful alignment with learners' experiences and mathematical goals. The study provides classroom-based evidence emphasising deliberate context use. Future research should explore scaffolding learners' contextual interpretation and the long-term impact of contextual teaching on mathematical learning.

Limitations of the Study

The study is limited by its small, purposively selected sample of nine Grade 9 learners from one class, restricting generalisability to broader or diverse contexts. Learners' socio-cultural backgrounds, language proficiency, and prior mathematical experiences may have influenced their responses to contextual tasks, making the findings context-specific rather than universal. Additionally, the researcher's dual role as teacher and observer, while enabling close insight into learners' sense-making, may have influenced learner behaviour and interpretations during instruction.

Recommendations

Based on the findings, mathematics teachers should deliberately and reflectively select contexts that are engaging and conceptually aligned with Grade 9 mathematical ideas, especially when introducing new concepts to reduce cognitive overload. Curriculum designers and teacher educators should provide professional development on the affordances and constraints of different contexts. Future research should examine contextual teaching across diverse settings and explore learners' development of contextual interpretation skills over time.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

AI-assisted technology was used to support the writing, editing, and proofreading of this manuscript. Specifically, ChatGPT was employed to enhance clarity, correct grammar, and provide suggestions for phrasing and structure.

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Consideration and the Content of “Informatics” Which Was Introduced From 2025 in the Common Test for University Admissions in Japan

Yoshiaki Nakano, Kogakuin University, Japan
Azu Azuki, Violence of Gakureki, Japan

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Official Conference Proceedings

Abstract

In 2025, “Informatics” was newly included as a required subject in the Common Test for University Admissions (CTUA) in Japan, which is used by all national and public universities and many private institutions. While “Informatics” has been a compulsory high school subject since 2003, it was long treated casually due to its exclusion from university entrance exams. This paper examines the educational significance of including “Informatics” in CTUA by analyzing the structure and content of the first-year exam taken by over 300,000 students, with an average score of 70%. The exam covers four key areas of “Informatics I”: (1) Problem-solving in the Information Society, (2) Communication and Information Design, (3) Computers and Programming, and (4) Information Networks and Data Utilization. The authors evaluated the exam items based on content balance, cognitive demand, and alignment with the high school curriculum. This analysis shows a well-balanced approach in addressing both conceptual understanding and applied skills, marking a significant shift in digital education policy. This inclusion has stimulated renewed attention to informatics education at the high school level and raised questions regarding curriculum alignment and teacher preparedness. The findings offer valuable insights into how national testing policies can drive curriculum reform and digital literacy education, with potential relevance to international contexts where informatics is still emerging.

Keywords: informatics education, curriculum reform, the Common Test for University Admissions in Japan (CTUA), information literacy, cross-disciplinary learning

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Introduction

In recent years, informatics education has gained increasing importance worldwide as digital technologies reshape both society and education. Japan has introduced substantial reforms to its national curriculum and university entrance examinations in order to enhance students' information literacy, computational thinking, and data utilization skills. A notable development is the introduction of the subject "Informatics I" into the Common Test for University Admissions.

This paper aims to (1) provide an overview of Japan's educational structure and ongoing curriculum reforms related to informatics education, (2) analyze the characteristics of the newly introduced Informatics I examination, and (3) discuss its implications for teaching, learning, and assessment in the context of contemporary information society.

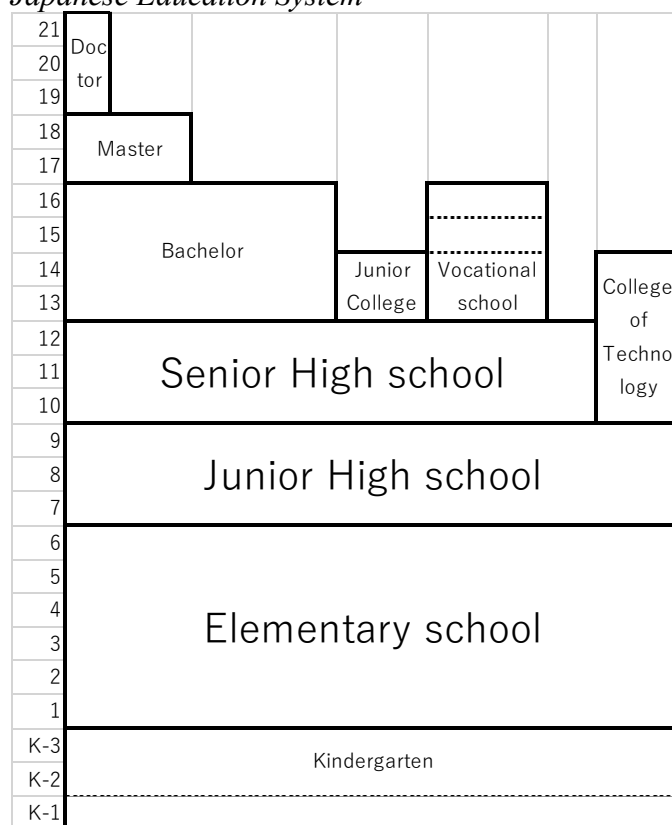
Overview of the Japanese Education System and Curriculum Reform

Structure of the Education System

The Japanese education system is generally structured as follows: kindergarten (2–3 years), elementary school (6 years), junior high school (3 years), senior high school (3 years), undergraduate programs (4 years), master's programs (2 years), and doctoral programs (3 years). In addition to this standard pathway, alternative options are available, including colleges of technology (5 years), junior colleges (2 years), and vocational schools (2–4 years) (Figure 1).

Figure 1

Japanese Education System



Primary and secondary education—from kindergarten through upper secondary school—is conducted in accordance with the national curriculum guidelines prescribed by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). These curriculum guidelines are revised approximately every ten years, and preparations for the next revision are currently underway.

At present, informatics education in Japanese primary and secondary education is implemented within “Integrated Studies” at the elementary level, within “Technology and Home Economics (Technology field)” at the lower secondary level, and within the “Informatics” subject at the upper secondary level. This paper first provides an overview of how these components are expected to change in the forthcoming curriculum revision currently under discussion.

Informatics Education in Elementary Schools

In elementary schools, informatics education is conducted mainly within “Integrated Studies,” where cross-curricular and interdisciplinary themes addressing contemporary issues—such as international understanding, information, environment, welfare, and health—are explored. A proposed reform seeks to divide these into a “Inquiry domain” and an “Information domain.” The Information domain would be further organized into small learning units called “Information Blocks,” which focus on fundamental information technology concepts, and “Mini Inquiry Units,” in which students learn and apply elements of information literacy through inquiry processes. This structure aims to substantially improve students’ information literacy at the elementary level.

Informatics Education in Junior High Schools

At the lower secondary level, the current “Technology and Home Economics” subject is expected to be divided into “Home Economics” and a new “Information and Technology” subject. Within this new subject, “Information Technology” will include topics such as programming for measurement and control, content and data, and the development of information technology and society. Additionally, “Production Technology Based on Information” will include materials processing, biological cultivation, energy conversion, and integrated practical activities. These reforms are intended to significantly strengthen informatics education.

Informatics Education in Senior High Schools

At the upper secondary level, the content of the compulsory subject “Informatics I” is expected to be reorganized from the current structure—

1. Problem Solving in the Information Society
2. Communication and Information Design
3. Computers and Programming
4. Information and Communication Networks and Data Utilization

—into the following framework:

1. Information Systems and Their Relationship with Society
2. Information Design and Design Thinking
3. Data Analysis, Modeling, and Simulation
4. Algorithms and System Development
5. Inquiry-Based Problem-Solving Using Information and Information Technology

Similarly, the advanced subject “Informatics II” is expected to evolve from:

1. Development of the Information Society and Information Technology
2. Communication and Content
3. Information and Data Science
4. Information Systems and Programming
5. Inquiry-Based Problem Discovery and Resolution

to a more advanced structure:

1. Social Issues and Data Science
2. Content Design
3. Artificial Intelligence
4. Advanced Technologies and Information System Design
5. Creative Problem Discovery and Solution Practices

The Common Test for University Admissions: “Informatics I”

Examination Characteristics

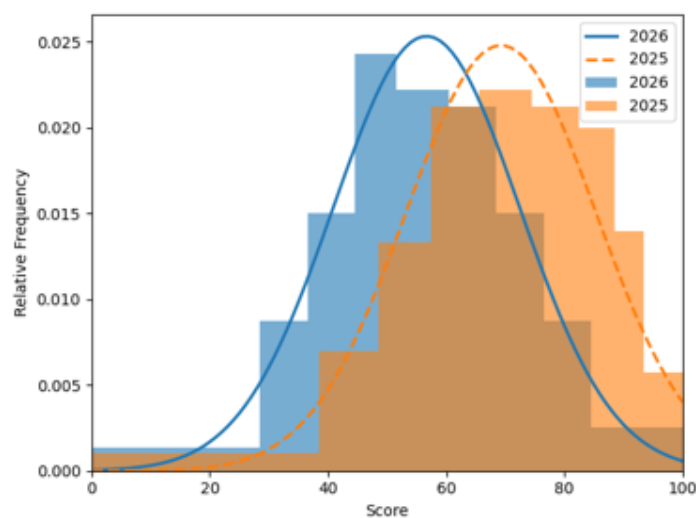
The Common Test for University Admissions subject “Informatics I,” first administered in 2025 and conducted for the second time in 2026, primarily featured questions requiring reasoning and judgment based on given scenarios rather than direct recall of isolated knowledge. For example, tasks such as estimating production workloads for cultural festival projects were presented using familiar contexts for high school students while encouraging consideration of system development processes such as requirements analysis and specification design. These questions appear to promote understanding of practical thinking processes in the informatics field.

In the programming section, a standardized pseudo-language independent of specific programming languages was used. This design helped minimize advantages or disadvantages arising from differences in learning environments or programming languages used by students.

Score Trends and Examination Structure

Approximately 300,000 students nationwide took the “Informatics I” examination. In 2025, the mean score was 69.26 out of 100 ($SD = 16.09$), while in 2026 the mean score declined to 56.59 ($SD = 15.72$) (Figure 2).

Figure 2
Stanine Distribution Chart



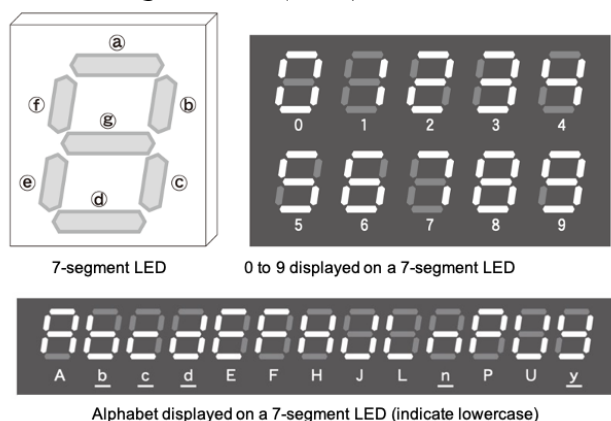
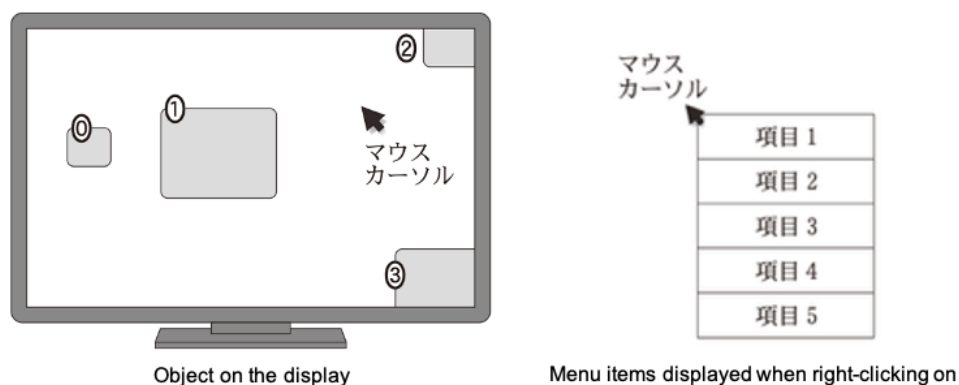
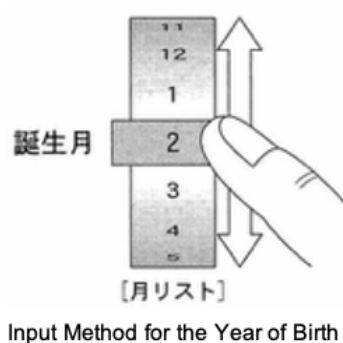
In the first year, roughly 30 points' worth of questions had correct answer rates approaching 90% (Figure 3). In contrast, such relatively easy items were absent in the second year, resulting in a lower average score but improved discriminative validity as a university entrance examination.

Figure 3
Correct Answer Rates by Question (2025)



Types of Examination Items

Examples of examination items included tasks involving seven-segment LED display patterns and determining the number of components required to display error codes (Figure 4). Other items addressed GUI design based on Fitts' Law (Figure 5) and smartphone user interface design (Figure 6).

Figure 4*Problem 1, Question 2 (2025)***Figure 5***Problem 1, Question 4 (2025)***Figure 6***Problem 1, Question 3 (2026)*

Beyond “Informatics I,” the Common Test frequently employs long conversational texts requiring contextual interpretation (Figure 7). Questions also addressed familiar information systems, focusing on data flows and system mechanisms (Figure 8, Figure 9). Simulation-based problems were included (Figure 10), as well as logical operations using image processing contexts (Figure 11).

Figure 7
Problem 2, A (2025)

A 高校生のYさんは、職業体験のため全国チェーンの総合スーパーマーケット「LikeWing」駒谷南店を訪れている。レジを担当したYさんと店長の会話文を読み、後の問い(問1～4)に答えよ。

Yさん：レシートにはたくさんの情報が印字されていますね(図1)。このレシートには「ポイント会員ID」が載っていますが、ポイントカードは店側にあってどんなよいことがあるのですか？

店 長：LikeWingでは、ポイントカードを作成する際に、お客様の名前、性別、生年の三つの属性情報をポイント会員情報として登録してもらっています。そして、(A)ポイント会員情報とレシートに印字されている情報を組み合わせて分析することで販売促進につなげています。

Yさん：それらの情報には大切な情報も多いですね。どう管理されているのですか？

店 長：はい。ポイント会員情報とレシートに印字されている情報は、LikeWingの本部の情報システムで一括して管理しています。(B)本部、各店舗、商品を製造するメーカー、商品を店舗に配送する配送センターの間で情報をやり取りして、商品は本部が一括して発注し、配送の指示を出します。

Yさん：LikeWingのネットショッピングサイトは有名ですね。そのネットショッピングサイトと、この情報システムはつながっているのですか？

店 長：今まさに、連携を検討しているところです。これらが(C)連携するメリットは多くあります。

Figure 8
Problem 2, A (2025)

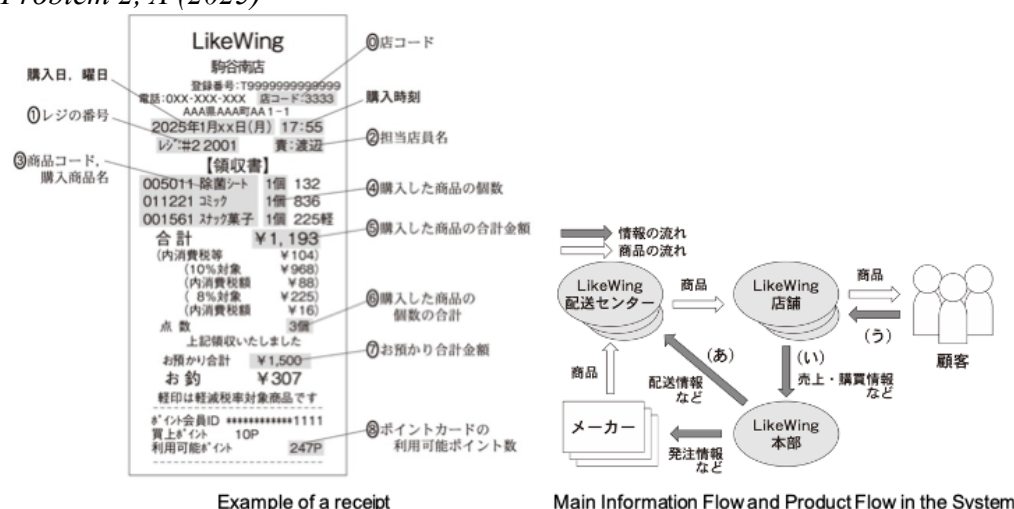


Figure 9
Problem 2, A (2026)

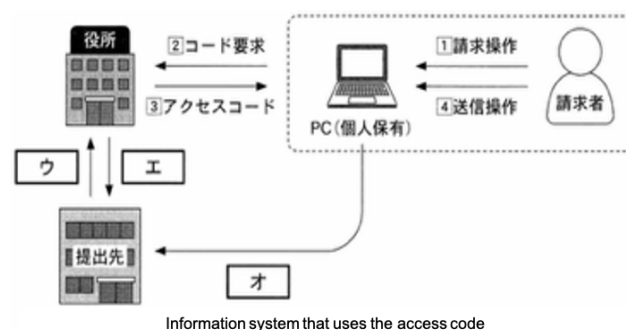
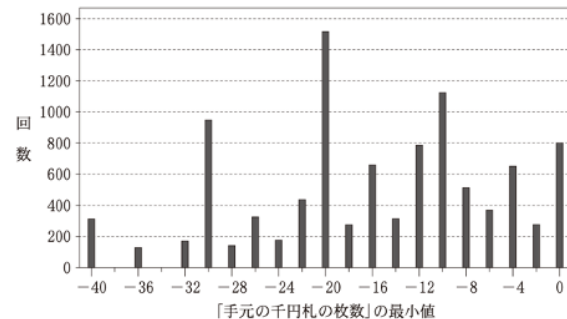


Figure 10
Problem 2, B (2025)

Changes in ¥10,000 and ¥1,000 Bills by Random Number r

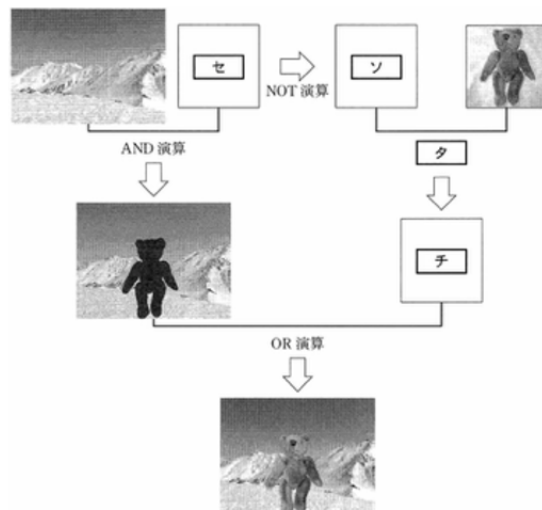
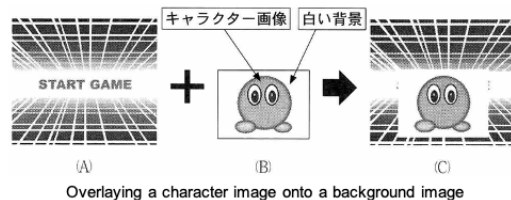
	乱数 r の値	手元の一万円 札の枚数	手元の千円札の 枚数
初期値		0	0
1人目	8	1	-4
2人目	1	1	2
3人目	6	2	-2
4人目	10	3	-6
5人目	9	?	?
6人目	4	コ	?
7人目	5	?	?
8人目	3	?	-サシ
9人目	7	?	?
10人目	2	?	?

(表の一部を“?”で隠してある)



Number of times the minimum value for ¥1,000 Bills

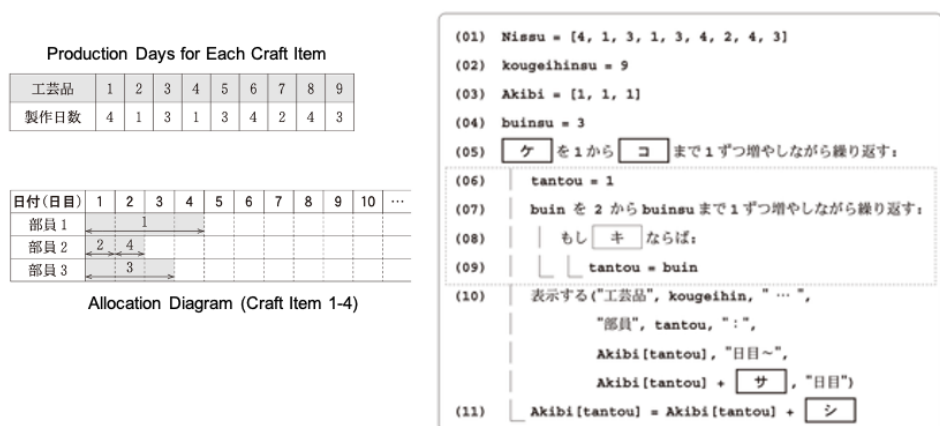
Figure 11
Problem 2, B (2026)



Procedure for compositing a portion of another image into a landscape image

Programming accounted for approximately one-quarter of the examination and was presented in Japanese using a standardized pseudo-code notation resembling Python syntax (Figure 12).

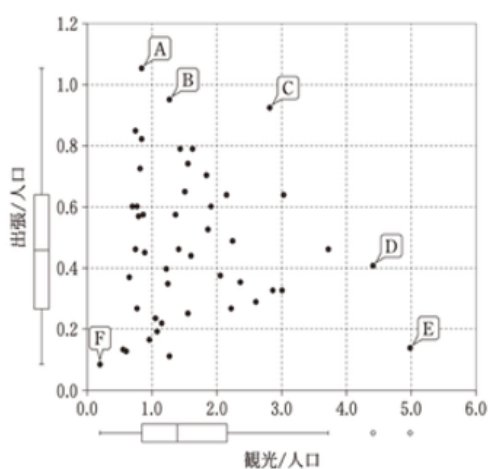
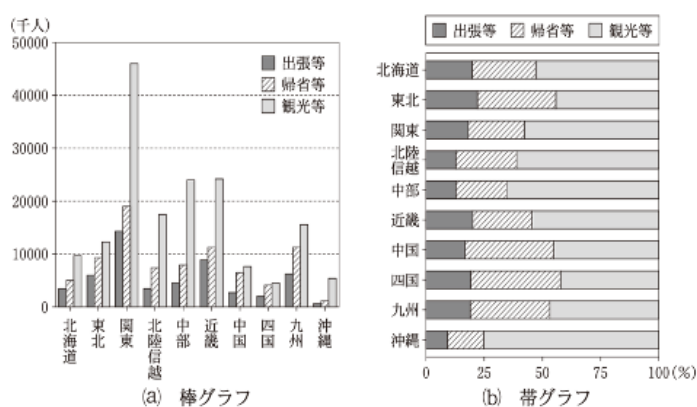
Figure 12
Problem 3 (2025)



Program Displaying the List of Assignments and Periods for Each Craft Item

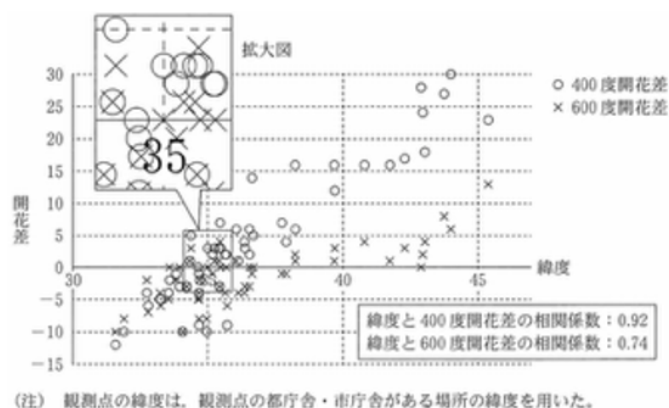
Data utilization also comprised about one-quarter of the exam, with a strong emphasis on graph interpretation (Figure 13, Figure 14).

Figure 13
Problem 4 (2025)



Scatter plot showing combinations of "Business Travel / Population" and "Tourism / Population"

Figure 14
Problem 4 (2026)



Scatter plot of latitude and differences in flowering time

Discussion

Shift Toward Cross-Disciplinary Thinking

Overall, “Informatics I” appears to be a subject requiring students to integrate knowledge and reasoning across multiple academic disciplines. Previous university entrance examinations often focused on the application of previously learned knowledge and were criticized for insufficiently measuring inquiry skills and practical application abilities. In contrast, “Informatics I” demonstrates potential as a response to these criticisms.

Many questions required cross-disciplinary thinking and appeared to assess abilities associated not only with informatics but also with creative professions—namely, the ability to generate new ideas by integrating diverse forms of knowledge.

Relevance to Contemporary Information Society

In recent years, the widespread adoption of smartphones and improvements in network infrastructure have significantly increased the volume of information encountered in daily life. Furthermore, the emergence of generative AI has made it possible to access vast amounts of information and potential solutions instantly. In such a context, the ability to evaluate, organize, and utilize information objectively—along with the ability to connect disparate ideas—is becoming increasingly important. The cross-disciplinary and applied nature of the “Informatics I” examination reflects this societal background.

Although generative AI enables individuals to create outputs more easily than ever before, producing original and innovative work requires the ability to integrate diverse perspectives and knowledge. The structure of this examination appears to reflect this growing need.

Creativity and Practical Competence

Another notable feature is the close alignment between examination content and real-world professional practices. The questions suggest that what students learn in school is directly relevant to practical work in society, helping to bridge the gap between academic learning and real-life professional contexts.

Challenges and Future Issues

Examination Weighting and University Utilization

One key issue for future consideration is the weighting of “Informatics I” within university entrance examinations and how widely it is utilized. Currently, more than 60% of universities allocate less than 10% of the total entrance examination score to this subject, indicating that its status remains relatively limited. Furthermore, while approximately 90% of national universities incorporate “Informatics I” into admissions decisions, only about 45% of public universities do so. If fostering information literacy and higher-order thinking skills is a priority, the influence of such weighting and utilization practices on students’ learning behaviors should be examined further.

Learning Environment and Teacher Expertise

Another challenge concerns the adequacy of the learning environment for “Informatics I.” A survey conducted by the learning application Studyplus found that only about 40% of students responded positively when asked whether they found Informatics I classes enjoyable. Reasons cited by students who responded negatively included insufficient teacher understanding, unclear explanations, and inadequate support for students struggling with the material.

From the perspective of operating a YouTube channel providing instructional content on Informatics I, feedback from learners and educators suggests that the subject is sometimes taught by teachers whose primary specialization lies outside informatics. Additionally, there appear to be considerable variations in content coverage and instructional depth among teachers. To maximize learning outcomes, improvements in teacher expertise and instructional systems, as well as enhanced learning environments within schools, are necessary.

Expanding Audience and Lifelong Learning

Another observation from operating a YouTube channel focused on Informatics I concerns the demographic characteristics of viewers. The audience is not primarily composed of high school students; rather, individuals in their 40s and 50s represent the largest demographic group.

This may reflect the fact that teachers from other subject areas are seeking instructional resources or conducting lesson preparation. It also suggests that mid-career professionals interested in acquiring informatics knowledge for professional development or personal growth are drawn to the subject matter covered in Informatics I.

Limitations

This study relies primarily on qualitative analysis of publicly available examination materials and score statistics. Classroom implementation, student learning outcomes, and longitudinal impacts were not empirically measured. Future research should incorporate classroom observations, teacher interviews, and student performance data.

Conclusion

Japanese curriculum reforms and the introduction of Informatics I represent a major shift toward evaluating applied reasoning, cross-disciplinary thinking, and practical competencies.

The examination aligns with societal changes driven by digitalization and generative AI. However, challenges remain regarding assessment weighting, teacher training, and learning environments. Addressing these issues will be essential to fully realize the educational potential of informatics education in Japan.

Acknowledgements

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The authors declare that Grammarly, an AI-assisted writing software, was used in proofreading and refining the language used in the manuscript. The usage was limited to correcting grammatical and spelling errors and rephrasing statements for accuracy and clarity. The authors further declare that, apart from Grammarly, no other AI or AI-assisted technologies have been used to generate content in writing the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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Contact email: johnny@nakano.ac

Examining Graduate Students' Opinions About the Impact of AI on Their Teaching

Holly Hansen-Thomas, Texas Woman's University, United States
Ann Wheeler, Texas Woman's University, United States

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Abstract

The importance of artificial intelligence (AI) in today's schools is ever-changing with a need to study how faculty, as well as emerging faculty, believe AI will shape their teaching philosophies. Therefore, this case study research examines written reflections of four doctoral students from the southern United States and their thoughts on the impact of AI on their current and future teaching. More specifically, the researchers wanted to know how graduate students involved in an online mentoring program focused on leadership development believe that AI will impact their future teaching. Each of the four participants were enrolled in a two-year graduate leadership program where students had dedicated faculty mentors, chosen by the mentees, who worked with them weekly, as well as two program directors who met quarterly with the mentees about their research projects. All of the graduate students had taught or were currently teaching at either a university or community college and had varying degrees of experience using AI in their own learning and teaching. Data for this study consisted of three months of written reflections with a focus on AI. The researchers coded the data using open and axial coding. Four main themes about how AI would influence the participants' teaching emerged from the reflection data: *Better Assignments*, *Ethical Concerns*, *Instructor Concerns*, and *Student Expectations*. The reflections revealed pros and cons of the use of AI in teaching and demonstrated evolving participant thoughts about its use. Implications for teaching and future research will also be discussed.

Keywords: artificial intelligence, graduate education, teaching

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Introduction

The use of artificial intelligence (AI) encompasses vast areas of today's educational settings. Even though there are potential benefits to the use of AI in education like personalized feedback, increased student motivation in learning (Vera, 2023), as well as instant grading and creating lesson plans (Bodinga, 2025), faculty are also skeptical. Iqbal et al. (2022) conducted a study in Pakistan of 20 faculty about the use of ChatGPT in the classroom, where concern was raised about its use, such as students developing plagiarism practices that would be detrimental to their learning. In addition, Iqbal et al. noted that most of their participants felt they needed help in understanding how to use the AI technology effectively in the classroom. Interestingly, Galindo-Domínguez et al. (2024) found in their study with 445 elementary through university teachers that "regardless of certain personal variables age, sex, educational stage, or field of knowledge, higher level of digital competence is associated with higher attitudes towards AI in Education" (p. 9).

With these ideas in mind, we decided to examine how AI has impacted graduate students who had been or were currently teaching in our research grant program. Would they be interested in using AI in their courses? Would they see strengths and/or weaknesses regarding the use of AI in teaching? More specifically, we were interested in answering the following research question: How do graduate students involved in an online mentoring program focused on leadership development believe that AI will impact their future in teaching in higher education?

Methodology

The participants in our study included four graduate students located in the United States who were accepted into the second cohort of a two-year graduate-focused research grant that emphasized leadership and a mentoring model where each graduate student was paired with a mentor of their choosing. The mentor was either a faculty member at the graduate student's institution or was a current faculty member of another institution of higher education in the United States. Graduate students were selected based on their research proposal for the grant program, which included majors from diverse backgrounds: Dance, Counseling Psychology, Rhetoric, and Sociology. Surprisingly, each participant was interested in becoming a professor, so we focused this research study on how the participants felt that AI might impact them in their future classrooms.

As part of the grant, graduate students completed weekly (10-hour or 20-hour) research with their respective mentors, as well as wrote monthly reflections about leadership-based podcasts, attended quarterly Zoom update meetings with their cohort and project directors, presented each semester about their research, and completed semesterly Google Form updates to their project directors. At the end of the program, each mentee also submitted a manuscript for publication. For this research, the data used came from the fall 2024 and summer 2025 written reflections about AI. (Note: Initially, the grant work included five graduate students, but one student did not complete the program, so her data was removed from the research.)

The two project directors gathered the data from the three sets of reflections from the fall 2024 and summer 2025 and compiled it into a Google Document for coding purposes. Open coding (Corbin & Strauss, 2008) techniques were utilized to arrive at four main themes in the data. In the Findings section, we will discuss these themes, as well as provide participant quotes.

Findings

In the coding, we examined reflections to see ways in which the graduate students felt AI influences their teaching and/or future teaching. We compiled the codes related to teaching from the reflections into four main themes: *Better Assignments*, *Ethical Concerns*, *Instructor Concerns*, and *Student Expectations* (see Table 1 for a breakdown of codes and themes). Pseudonyms were utilized for each graduate student.

Table 1
Thoughts on AI as a Teacher

Themes	Codes (with B = Bri, C = Charlee, K = Kirsten, and H = Harper)
Better Assignments	be more creative with assignments (B, C), include new ideas for in-class presentations (H), improve student learning outcomes(H), carefully design assignments (K),
Ethical Concerns	environmental concerns (B, H), plagiarism (K), detect cheating (H), plagiarism checker (K), student voice and invention (K)
Instructor Concerns	giving AI control for presentation creation (B), be more knowledgeable about AI (B), overuse of AI (H), inaccurate and misleading information (K)
Student Expectations	be clearer to students about assignment expectations (B), standardize and communicate expectations to students (H), explicitly state AI class policies (K), grammar and language support (K)

As can be seen from the above table, all participants felt that AI can help instructors to create better assignments due to the power that AI can have over the educational process. A student can input various simple prompts into generative AI models and obtain instant feedback on a myriad of topics. Thus, the participants saw the need for better prompts and new ways to present class content.

With the other three main themes, three of the four participants discussed these concerns and expectations in their reflections. To better examine these themes, we will detail each student's thoughts about AI from a teacher's perspective in the following paragraphs. Let us start with Bri's reflections.

Bri

During the second year of the grant, Bri, a Sociology major, was teaching a university course in her discipline. In her monthly reflections, she described the influence of AI on her as a teacher and student. She discussed the lengths of time she spent trying to craft a well-thought-out AI policy in her syllabus, as well as assignments for her course. In the below quote, she described her detailed thought processes behind classroom assignments like presentations and writing assignments.

If I offered my students an assignment that included a presentation, I would evaluate them on the quality and design of their slides, but it would be a small part of the overall grade because there are so many tools that can help to create beautiful slide decks from

just an outline. Similarly, I grade students on their use of professional and academic language in their writing, but this is not a significant portion of the grade because there are many tools to help them do this.

Bri understood the power of AI and wanted to make sure that students were not just cheating their way through her course. She further elaborated on how she emphasized her desire to “hear” the students’ own voice in her assignments to help curb the over-reliance of students’ use of AI.

I ask them [students] to create writing that reflects their personal experiences and how that connects to the sociological themes we are studying. I know that AI can generate a reflection. Still, over the semester, I have become familiar with their writing styles and histories, and I know their opinions about various topics...I focused my comments [in class] on how much I love to hear their voices in their work, and AI tends to take that away. I told them it was my pleasure to know them through their writing and that I lost out when they use AI.

Bri was intentional on how she crafted better assignments and set student expectations to be able to try to address her concerns about AI use in the classroom, as well as ethical issues she had with student cheating with AI.

Charlee

Like Bri, Charlee, a Dance major, was balancing being a doctoral student and instructor. She was new to using AI in the classroom and did not speak much about its use for her teaching. Through her reflection work, Charlee discussed her reservations about AI and how best to utilize it in her classes.

I have mixed feelings about the use of AI in education. I have been experimenting with how to incorporate it into my courses. In one of my dance history classes this semester, I am asking the students to use ChatGPT to write a narrative about some historical figure in dance and then write a counternarrative by themselves. Though we haven’t gotten to this assignment yet, I am hoping it will help them see that all history is narrativized and we have to critically think about how these stories are crafted and what implicit and explicit biases are embedded within them.

In her reflection about AI, Charlee discusses how she plans to use it in her course to make a better assignment but not how she has actually used it yet, which might explain why she did not discuss this aspect of AI use much in her reflections.

Harper

Unlike Bri and Charlee, Harper, a Counseling Psychology major, was not currently teaching but had taught in the past and aspired to be a professor. In her reflection writing, she focused on the plagiarism tool Turnitin, an ethical concern of hers, and its usefulness in the classroom:

I was grateful for Turnitin’s AI-detection feature, as it allowed me to see, more often than not, where AI might have been used in students’ essays...

Another major theme that Harper mentioned in her reflections about teaching was the overuse of AI, an instructor concern. In her reflections, she clarifies her statements by discussing her fear of relying too heavily on AI:

I understand that one of the common pitfalls of utilizing AI tools is the potential for over-utilization. As a future educator, I hope to impress upon my students that while AI is capable of generation, there are human skills necessary to facilitate their learning. I think it is important to note that while AI increases convenience, it does not replace the process of obtaining an education.

Harper goes on to discuss how AI does not show emotion or creative skills that a human can produce with replication and summarizing being AI's main functions. She also feels that teachers need to "standardize and communicate expectations to students," which are expectations the students should meet in her classroom.

Kirsten

Lastly, Kirsten, a graduate student majoring in Rhetoric, discussed the usefulness of AI tools like Turnitin to detect plagiarism, an ethical concern, in student work, as well as how these programs have helped students be more cautious of overreliance on AI, an instructor concern, in their writing:

By opening this line of conversation with students that are suspected of, or openly admit to using AI, students can learn to be more critical of their AI use in academic contexts, and consider the possibilities and limitations of this work. AI also has implications for student voice and invention, two major rhetorical concerns that guide writing literacy.

Even though Kirsten acknowledged the benefits of AI in education, she does see ethical dilemmas in its use with "a fine line between using AI for sentence stems or transitional phrases, and plagiarizing ideas for exposition." Kirsten goes on to discuss how AI can also provide inaccurate summaries of articles and incorrect citations. She even gives examples of assignments that might be nice alternatives, better assignments, to combat AI tools, including self-made podcasts:

I think it could be helpful if instructors carefully designed assignments in a way that would make it more difficult to use AI, since it is not necessary for every assignment. Or, instructors could explicitly state which assignments can or cannot utilize AI when designing these prompts. For example, my Composition II students create a podcast project which captures their authentic reactions, ideas, and voices in real time. It will be interesting to see what some others have come up with when using AI for their own research projects and goals.

Conclusion and Future Work

As can be seen from the graduate students' reflections, there exists various benefits and challenges with AI use in education, which is similar to findings from other researchers (Iqbal et al., 2022; Vera, 2023). In our work, these areas manifested as our four main themes: *Better Assignments*, *Ethical Concerns*, *Instructor Concerns*, and *Student Expectations*. Even though students can become too reliant on its output that they might lose sight of how to critically evaluate its answers and become lazy in their studies, instructors could become more creative

in their assignments, which could lead to better assignments and deeper learning. AI is here to stay, and we need to continue to study its uses in education and ways in which our current and future educators are redefining learning for future generations.

For future work, we are interested in how educators grow over time in their use (or lack thereof) of using AI in their teaching in higher education. This new generation of teachers has grown up being exposed to AI in their own studies and seen the pros and cons of its use. Will they be more likely to evolve their teaching philosophy to adopt AI or will they be more likely to be wary of its use and seek other resources for themselves and/or for their students to utilize for learning. Time will only tell.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that Grammarly, an AI-assisted writing software, was used in proofreading and refining the language used in the manuscript. The usage was limited to correcting grammatical and spelling errors. Further, the authors declare that databases and ChatGPT were used to help with putting references in APA format.

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Contact email: hhansenthomas@twu.edu

Faculty Mentorship for Underserved Senior STEM Students: Insights From a Hispanic-Serving Institution

Elodie Billionniere, Miami Dade College, United States
Lawrence Meyer, Jr., Miami Dade College, United States

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Abstract

This paper reports the role of faculty mentorship in supporting underserved and low-income upper-division students in STEM fields at the largest undergraduate Hispanic-Serving Institution in the United States. The evaluation focused on 49 students in Fall 2024 and 39 in Spring 2025, all in their senior year and enrolled in one of three bachelor's programs: Data Analytics, Cybersecurity, or Information Systems Technology. Faculty mentorship was provided during the final two years of the students' programs, in addition to general academic advising. The evaluation examined changes in scholars' self-ratings of program and mentorship satisfaction, as well as confidence, sense of belonging, and perceived support. Comparisons by gender and degree program revealed no statistically significant differences across semesters in student perceptions, suggesting a consistent mentoring experience. Qualitative findings were gathered from a focus group and follow-up questionnaire with three faculty mentors—one from each program. Mentors described adaptive, student-centered approaches that included academic support, development of soft skills, and career preparation. They also emphasized building trust and tailoring guidance to individual student circumstances, such as employment demands and limited experience in professional environments. Faculty noted the positive impact of mentorship on student motivation and persistence, particularly for those navigating barriers like imposter syndrome or financial hardship. Recommendations included structured mentor training, access to industry professionals, and improved hands-on learning opportunities. Mentors also reported personal growth in teaching and advising through a deeper understanding of student needs. These findings provide practical insights for designing effective mentorship initiatives for underserved STEM students approaching graduation.

Keywords: faculty mentorship, underrepresented students, community college, computing education

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Introduction

Mentorship is a critical mechanism for supporting underserved and low-income students in STEM pathways, particularly at Hispanic-Serving Institutions (HSIs) where many students balance academic, financial, and familial responsibilities. This research report highlights the role and impact of faculty mentorship within the Rebooting through EmTech Program (REP), an initiative supporting upper-division students in Data Analytics, Cybersecurity, and Information Systems Technology at Miami Dade College (MDC), the largest undergraduate HSI in the United States. The REP program integrates financial support, professional development, and structured faculty mentorship, offering a unique opportunity to study how individualized guidance influences academic outcomes, psychosocial development, and career readiness among students nearing graduation. This evaluation focuses on seniors nearing graduation and examines how mentorship relates to confidence, belonging, perceived support, and academic outcomes.

Drawing upon a comprehensive evaluation—including two semesters of scholar surveys, a faculty mentor focus group, follow-up mentor questionnaires, and regression analysis of academic datasets—this report provides detailed insights into how faculty mentorship strengthens students' confidence, learning experiences, and persistence. It further investigates faculty perspectives on mentoring, highlighting their strategies, challenges, and reflections on professional growth.

STEM Faculty Mentoring in Computing and Technology

A substantial body of research confirms that faculty mentoring is a critical predictor of persistence and success in STEM disciplines. Mentored STEM students are more likely to develop strong scientific identities, engage in research opportunities, and persist through challenging coursework (Estrada et al., 2016; Estrada et al., 2018). In computing and technology fields specifically, mentoring relationships help students deepen technical mastery, contextualize theoretical knowledge through real-world applications, and understand pathways into competitive careers (Turner, 2023; Wimberly et al., 2022).

Faculty mentors who guide students through projects, certification pathways, and portfolio-building contribute significantly to students' readiness for the tech workforce. Effective mentoring in computing also includes feedback on professional materials (résumés, GitHub portfolios, LinkedIn profiles), guidance on industry expectations, and exposure to professional networks. These practices have been linked to improved self-efficacy and persistence among computing majors, particularly through mechanisms such as goal setting, normalization of struggle, and high-quality mentor-mentee interactions (Kuchynka et al., 2023).

Mentoring Underserved and Underrepresented Students in STEM

Underserved and underrepresented students—including Black, Hispanic, first-generation, and low-income learners—face unique systemic barriers in STEM. These include limited access to academic resources, fewer opportunities for early exposure to STEM careers, financial pressures, and experiences of marginalization within academic settings. High-quality mentoring relationships can play a powerful role in mitigating these inequities (Byars-Winston & Dahlberg, 2019; McGee, 2019).

Culturally responsive mentoring has been shown to improve belonging, confidence, and persistence for underrepresented STEM students. Mentors who validate students' cultural identities, acknowledge systemic barriers, and guide students in navigating institutional structures foster stronger academic and psychosocial outcomes (Morales et al., 2021; Pedersen et al., 2022). Among Latinx and Black students in particular, mentorship emphasizing encouragement, communication, and advocacy is associated with increased interest in graduate study and stronger commitments to STEM careers.

Research on HSIs shows that supportive relationships, community-building, and culturally aligned mentoring practices are central to promoting STEM success for Hispanic students. Such approaches underscore the importance of intentional practices that foster equity and meaningful learning experiences rather than merely enrolling high numbers of Hispanic students (McGee, 2019; Morales et al., 2021).

The present study contributes to this expanding literature by looking at faculty mentorship in computing-related bachelor's programs at an HSI. It provides empirical evidence on how mentorship shapes academic confidence, belonging, and career readiness among underserved senior STEM students.

Program Overview

MDC enrolls a student body that is 73% Hispanic, 16% Black (non-Hispanic), 57% women, 68% low income, 35% ESL, 58% first-generation, and 54% age 21 or older. Nationally, MDC has the highest enrollment of Hispanic undergraduates (81,398) and ranks third in Black (non-Hispanic) undergraduate enrollment, reflecting its significant role in expanding access to higher education for historically underserved populations. In alignment with MDC's mission to support its diverse and predominantly underserved student body, the REP program offers targeted financial, academic, and professional development support to help senior students in emerging technology bachelor's programs thrive. A central component of the program is EmTech Connect, which pairs each scholar one-on-one with a dedicated faculty mentor who offers tailored academic and career guidance. Students further build their professional competencies through Savvy Tech Workshops that strengthen confidence, workforce readiness, and self-promotion. Career preparation is additionally supported through the Leadership Rotation Academy, which offers structured opportunities for undergraduate research, internships, and industry certification training, as illustrated in Figure 1.

Figure 1

REP Support Framework by Term and Activity Frequency

Fall	Spring	Summer
• Financial Literacy (1) • EmTech Connect (1–3) • Savvy Tech (3)	• Financial Literacy (1) • EmTech Connect (1–3) • Savvy Tech (3) • Tech Speaker Series (1)	• Leadership Rotation Academy Track (1)

Designed to improve degree completion and workforce readiness, the REP program serves scholars who often identify as first-generation, low-income, adult learners, or students working full- or part-time jobs. Given these realities, faculty mentorship plays a critical role in supplementing traditional academic advising and helping students navigate personal, academic, and career obstacles.

Methodology

The evaluation uses a mixed-methods approach to capture both the measurable outcomes of student experiences and the qualitative nuance of mentoring interactions, as summarized in Table 1.

These data sources provide a comprehensive foundation for examining both quantitative and qualitative aspects of the REP experience. Quantitatively, paired t-tests were conducted to examine semester-to-semester changes in confidence, support, belonging, and satisfaction, while multiple regression and logistic regression were used to assess predictors of GPA, course pass rates, and persistence. Qualitatively, inductive thematic analysis was applied to mentor responses to identify and synthesize themes related to mentoring strategies, challenges, student barriers, and mentor growth.

Table 1
Summary of Data Sources

Data Source	Description	Sample Size	Timing
REP Scholar Survey	Online surveys assessing confidence, belonging, satisfaction, support, and mentoring experiences	N = 49 (Fall 2024); N = 39 (Spring 2025)	Fall 2024 & Spring 2025
Faculty Mentor Focus Group	Virtual discussion exploring mentoring strategies, student needs, and program improvements	2 faculty mentors + 1 written response	April 2025
Mentor Follow-Up Survey	Open-ended questionnaire elaborating on mentoring practices and challenges	3 faculty mentors	Spring 2025
Student Outcomes Data	Institutional data on GPA, course pass rates, and persistence	769–512 observations	Fall 2024–Spring 2025

Results

REP Student Demographics

The demographic profile of REP scholars remained largely consistent across semesters. As shown in Table 2, the participants are predominantly male, with approximately half identifying as Hispanic/Latino(a/x). Racial and ethnic backgrounds were diverse overall. Employment patterns shifted in the spring, with increases in both full- and part-time work. Participation in professional development activities showed modest changes, with internships increasing while certification and undergraduate research involvement remained relatively stable.

Table 2*Summary of REP Scholar Demographics (Fall 2024–Spring 2025)*

Category	Fall 2024 (N = 49)	Spring 2025 (N = 39)
Gender	Man: 35 (71.4%); Woman: 12 (24.5%); non-binary: 2 (4.1%)	Man: 28 (71.8%); Woman: 11 (28.2%); non-binary: 0 (0%)
Race/Ethnicity	Hispanic/Latino(a/x): 23 (47.9%); Black/African American: 11 (22.9%); Asian/Pacific Islander: 1 (2.1%); White: 0 (0%); Two or More Races: 13 (27.1%); Prefer not to say: 1 (2.0%)	Hispanic/Latino(a/x): 20 (51.3%); Black/African American: 8 (20.5%); Asian/Pacific Islander: 2 (5.1%); White: 1 (2.6%); Two or More Races: 8 (20.5%); Prefer not to say: 0 (0%)
Employment Status	Full-Time: 6 (12.2%); Part-Time: 0 (0%); Not Employed: 43 (87.8%)	Full-Time: 7 (17.9%); Part-Time: 7 (17.9%); Not Employed: 25 (64.1%)
Professional Activities	Internship: 6 (12.2%); Certification(s): 18 (36.7%); Undergraduate Research: 3 (6.1%)	Internship: 8 (20.5%); Certification(s): 12 (30.8%); Undergraduate Research: 2 (5.1%)

Quantitative Findings

As summarized in Table 3, the quantitative analysis indicates that REP participation was associated with higher academic performance, particularly in overall pass rates, while GPA and persistence outcomes showed more modest or mixed patterns. While GPA results varied across semesters, the trend suggests potential academic benefits for REP scholars in Spring 2025. Persistence outcomes showed no meaningful differences, indicating that retention may depend on factors beyond the program's scope. Overall, the findings suggest to REP's potential effectiveness in improving academic outcomes for participating students.

Table 3*Summary of Quantitative Findings*

Outcome Variable	Significant Predictors	Significance	Interpretation
Overall Pass Rate	REP Participation; Hispanic Identity	$p < .01$; $p < .10$	REP students performed better on average
Fall 2024 GPA	None	n.s.	No major differences detected
Spring 2025 GPA	REP Participation (modest)	$p < .10$	REP mentorship may support GPA gains
Persistence	None	n.s.	No predictors achieved significance

Student Experiences With Faculty Mentorship

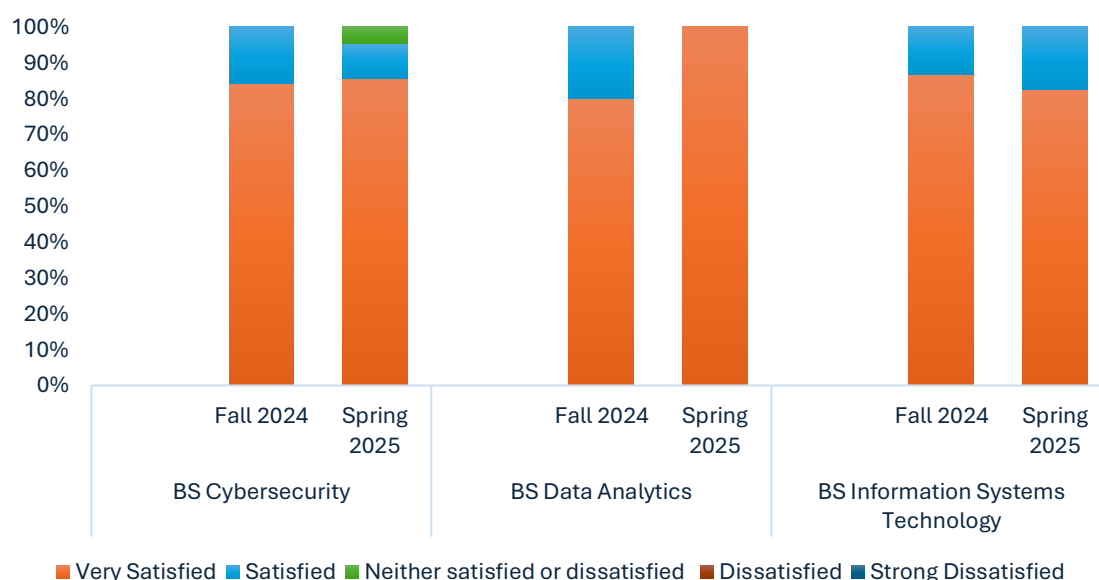
Survey data demonstrated that mentorship significantly shaped students' perceptions of their academic potential, sense of belonging, and confidence in technology-related tasks. In addition to quantitative ratings, students shared feedback that highlights the meaningful role of

mentorship. Students praised the REP program in many aspects and were interested in even more networking opportunities, mentorship, and resources. Several students also indicated that additional support related to certifications would be valuable, noting that “preparation materials for industry certification would be helpful.” These sentiments suggest that while mentoring experiences were overwhelmingly positive, scholars desired even more structured opportunities to connect with mentors and strengthen career preparation.

Across all three programs, REP scholars reported high satisfaction with faculty mentorship in both semesters. Overall satisfaction patterns by program and term are displayed in Figure 2, which shows consistently positive perceptions across semesters.

Figure 2

Mentoring Satisfaction by Degree Program and Semester (2024–2025)



Further indicators of student perceptions—including confidence, faculty support, and belonging—are summarized in Table 4, which shows high and stable ratings across both semesters.

Table 4

Student Perception Summary

Theme	Fall 2024	Spring 2025	Interpretation
Mentoring satisfaction	~98% satisfied	100% satisfied	High, stable satisfaction
Confidence in academic skills	94–100%	95–100%	Students felt academically capable
Faculty support	93.9%	100%	Students perceived active, consistent support
Belonging in major	98%	100%	Strong academic identity
Campus belonging	Slightly lower	Similar trend	Campus climate may limit belonging

Students frequently emphasized that consistent communication with mentors alleviated confusion about coursework, strengthened motivation, and provided clarity regarding post-graduate pathways. Key student challenges were:

- Managing work shifts alongside full-time coursework
- Supporting family members or managing household responsibilities
- Financial insecurity, even with stipends
- Lack of confidence in soft skills such as communication or networking

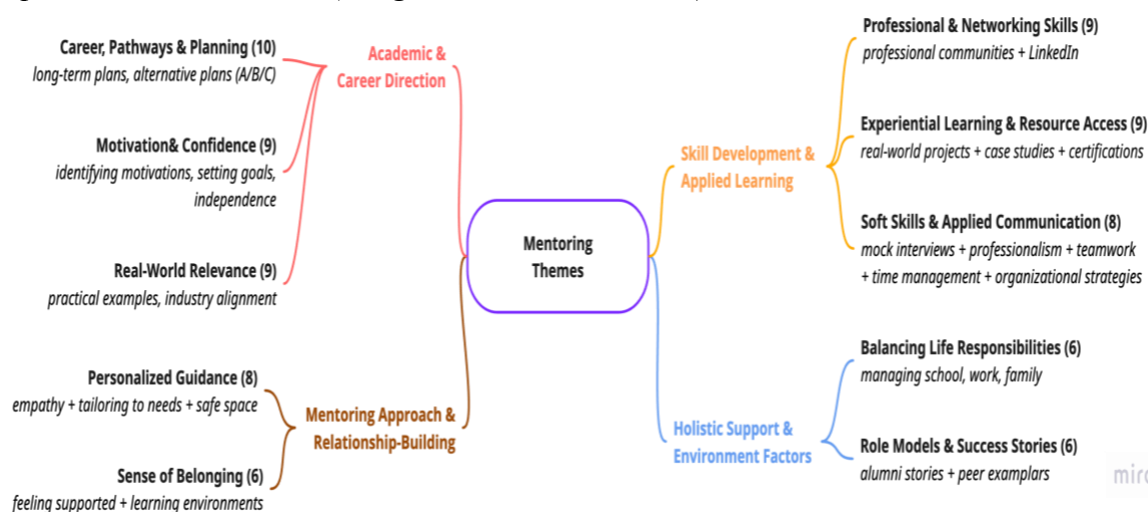
Students who struggled with these challenges were often those who benefited most from mentor reassurance and goal-setting guidance.

Faculty Experiences With Student Mentorship

Faculty mentors described their experiences as deeply rewarding and emphasized flexible, student-centered approaches grounded in empathy, real-world guidance, and professional development. The most frequently cited mentoring themes are presented in Figure 3.

Figure 3

Top 10 Combined Themes (Weighted and Consolidated)



Faculty emphasized time management coaching, organization strategies, and helping students develop sustainable academic habits. One mentor explained, “Emphasizing time management and providing tools like planning templates also empowers them to stay organized and succeed academically.” Mentors also guided students through reflective processes, helping them monitor progress and set achievable goals: “I help students reflect on their progress, identify areas for improvement, and set realistic, achievable milestones.”

A key mentoring strategy was fostering independent thinking. Rather than giving answers directly, mentors encouraged inquiry-based learning: “Force feeding them information rarely is effective [...] I want them to poll me for questions I helped spark in their mind, as then it will be their own thought.”

In addition to academic support, mentors invested heavily in students’ professional development. They conducted mock interviews, provided communication and networking coaching, and guided students in understanding real expectations in the tech sector. One mentor

noted, “As a programmer, if you don’t have anything built, I’m going to question why... You have to demonstrate you really want it.” This approach helped students develop both technical and soft skills essential for entering the workforce.

Faculty also incorporated technology and real-world applications into their mentoring. Mentors used LinkedIn, virtual meetings, and free online training resources, stating, “Yes, I have recommended multiple online free resources [...] to provide statistical data on requirements for career paths.” Another mentor discussed using industry case studies and “what-if” scenarios to help mentees understand the landscape of computing careers.

Importantly, mentors described mentorship as personally meaningful. One mentor shared, “I believe it is me paying back for the mentors who have allowed me to succeed in my career.” Mentors also expressed joy in witnessing student success: “Watching the mentees graduate, get jobs, and come back to my classes to talk with the next generation [...]” These reflections show how the mentoring relationship is reciprocal, contributing to faculty members’ growth in empathy, motivation, and teaching practices.

Mentors also acknowledged areas for improvement. They expressed a desire for more structured mentoring frameworks, enhanced training, and better access to tools such as headhunting data and industry networks. One mentor remarked, “One benefit is to have a mentorship class for the mentors. Not everyone is skilled in the skillset.” and another emphasized that “creating a more structured framework for mentoring activities and increasing collaboration between mentors and faculty could enhance the overall effectiveness of the program.”

Discussion

The perspectives shared by students and faculty point to a mentoring structure that feels practical, supportive, and closely connected to students’ day-to-day academic experiences. Students often described their mentors as approachable and helpful, noting that the guidance they received made it easier to manage coursework, clarify goals, and make decisions about their next steps. Faculty, for their part, reinforced this view, describing mentorship as an engaged and adaptive process that incorporates regular communication, individualized support, and pragmatic advice regarding academic progress and career pathways. Taken together, these perspectives demonstrate that mentoring in REP is more than a supplemental service; it is a core component of how students are supported during their final year in the program.

Across surveys and focus group discussions, both groups highlighted the importance of communication, trust, and individualized support. Students appreciated mentors who could help them sort through academic, personal, or financial challenges, and faculty emphasized the importance of understanding the circumstances students bring with them. Faculty mentors also discussed drawing from their own professional experiences, helping students make sense of what to expect in tech-related fields and how to build the skills needed to enter the workforce. These interactions contribute not only to academic growth but also to students’ confidence and readiness for life after graduation.

Overall, the findings suggest to mentorship as a key factor in strengthening students’ sense of belonging and persistence in STEM. By responding to the specific challenges students face and by offering steady academic and career guidance, faculty mentors help create an environment

where REP scholars can succeed. Table 5 summarizes these perspectives and highlights how students and faculty view the mentoring relationship in mutually reinforcing ways.

Table 5
Combined Perspectives

Category	Student Perspective	Faculty Perspective	Combined Insight
Academic confidence	Students felt highly confident	Mentors built confidence intentionally	Reinforces students' self-efficacy
Career readiness	Students prepared for tech careers	Mentors guided career exploration	Mentorship bridges classroom & workforce
Belonging	Strong belonging in major	Mentors normalized challenges	Academic identity strengthened by mentorship
Barriers	Students face time & financial constraints	Mentors tailor support to context	Mentorship mitigates systemic inequities

Quantitative analyses further indicate that REP participation is associated with positive academic outcomes. Particularly, students in the program demonstrated an 11.27 percentage-point increase in course pass rates overall, and REP scholars showed modest GPA improvements in Spring 2025. Additionally, student perceptions of the program remained consistently positive across semesters and demographic groups. As such, these outcomes suggest that sustained faculty engagement provides a stabilizing and supportive influence that enhances both academic performance and students' overall program experience.

Conclusion

Faculty mentorship plays a transformative role in supporting underserved senior STEM students at a major HSI. The REP program's mentorship model strengthens students' academic confidence, sense of belonging, and career readiness, while helping them navigate complex personal and structural barriers. Faculty mentors emphasized that understanding students' lived experiences, building trust, and offering concrete career preparation were essential to effective mentoring.

Quantitative results demonstrate meaningful improvements in academic performance, particularly in course pass rates, further validating the program's impact. Qualitative findings enrich this understanding by revealing the depth of mentor-mentee relationships and the significant personal growth experienced by both students and faculty.

To maximize the impact of mentorship in future iterations of REP or similar STEM education initiatives, recommendations included structured mentor training, expanded access to industry partners, enhanced soft-skill development opportunities, and improved communication of campus resources.

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Teaching on Shifting Ground: A Self-Study of AI Policy, Practice, and Online Graduate Education

Georgann Cope Watson, Yorkville University, Canada

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Abstract

This paper reports on a Self-Study of Teacher Educator Practices (S-STEP) examining how rapidly evolving institutional policies and guidelines for generative artificial intelligence (AI) have influenced my teaching and assessment practices in online, asynchronous, graduate level courses with standardized, pre-developed curricula across multiple institutions in three Canadian institutions. The central research question guiding this inquiry is: How has the development of policy around AI use in academic courses impacted my practice of teaching and assessment? Findings indicate that (1) policy ambiguity has operated as a productive catalyst for reflective pedagogical change; (2) policy discourse has reoriented assessment away from product-focused evaluation toward process-oriented design foregrounding transparency and student voice; (3) policy evolution has legitimated deliberate, ethical educator use of AI for planning and formative learning support; and (4) policy gaps have expanded the educator's role as an ethical guide and designer of AI-integrated learning environments. The study draws on institutional documents, course artifacts, reflexive journaling, and critical-friend dialogue, analyzed through iterative thematic coding and triangulation. The findings suggest that policy acts less as prescriptive instruction and more as a stimulus for inquiry-led redesign, leaving substantial interpretive responsibility at the instructor level. Implications include the need to embed AI literacy, articulate course-level AI permissions and disclosure expectations, protect student data privacy by prohibiting uploads to public large language models, and align assessment with authentic processes in asynchronous, pre-developed curriculum contexts. The paper concludes with next steps for deepening the S-STEP, attending to socio-cultural considerations (including Indigenous education and international student experiences), and monitoring policy developments that shape faculty autonomy and ethical practice.

Keywords: generative AI, academic integrity, institutional policy, teacher educator practice

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Introduction

Over the past two years, generative AI has become a pervasive presence in higher education, reshaping how students write, study, and demonstrate learning, and how educators plan, assess, and provide feedback. As an educator teaching online, asynchronous, graduate level courses with standardized, pre-developed curricula across multiple institutions, I have encountered both excitement and uncertainty as institutional policy frameworks have attempted to catch up with practice. While much scholarly and practitioner attention has focused on academic integrity and student use, there remains comparatively less inquiry into how faculty practice is transformed by policy signals that are still in flux. This paper responds to that gap through a self-study of practice (S-STEP), asking: How has the development of policy around AI use in academic courses impacted my practice of teaching and assessment?

My context comprises teaching roles at two mid-sized universities and one college. Across these settings, I teach in asynchronous formats, where course shells are pre-configured and faculty enactment occurs primarily through facilitation, feedback, and assessment within established curricular constraints. In such environments, academic integrity concerns surface acutely, and institutional guidance tends to be absorbed into course-level expectations, rubrics, and communications. The study thus situates policy as a lived, interpretive phenomenon rather than a static compliance checklist.

Methodologically, the self-study integrated iterative journal reflections, evolving policy and guideline of GenAI and academic integrity analysis, and critical-friend dialogue to trace how policy statements, updates, and institutional communications translated into changes in my day-to-day decisions about assignment design, communication with students, and personal use of AI for planning and feedback. The aim of this study was to surface principles and practical strategies that can inform teacher educators navigating similar constraints in online, asynchronous graduate education.

Institutional Policies/Guidelines

Across the three institutions examined, policies and guidelines vary in explicitness, scope, and tone of enforcement, yet they converge on several themes: transparency, respect for academic integrity, instructor modeling of responsible use, and strong prohibitions on uploading student work to public AI systems. The tabled summary in the original presentation highlighted these convergences and divergences, which I narratively synthesize here. Note: policies and guidelines may have changed since this research was completed.

The College frames faculty use of generative AI as permissible when purposeful, aligned to learning outcomes, and transparently communicated to students. Course-level clarity is central: instructors are expected to specify whether student AI use is permitted, restricted, or prohibited, and to include expectations in course outlines and assignment instructions. Importantly, faculty are cautioned not to rely solely on AI-detection tools when addressing potential misuse, instead following established academic integrity procedures. This guidance balances educative intent with procedural clarity, situating discretion at the course level while discouraging overreliance on imperfect detection technologies.

University 1 emphasizes academic integrity and transparent use. Students may use generative AI only if they clearly identify and properly cite AI-generated contributions (e.g., in APA style). Faculty are expected to model responsible use, integrate AI literacy into courses where

appropriate, and, critically, must not upload any student work to any large language model including any academic check tools, a measure designed to safeguard student privacy and data sovereignty. While detection mechanisms are not specified, the thrust is preventive: normalize responsible use and disclosure, prohibit misrepresentation, and protect student data.

University 2 does not (at the time of data collection) maintain a policy; instead, AI guidance is embedded in the academic integrity framework. Notably, the institution amended procedures in November 2024 (effective May 5, 2025) to classify unauthorized AI use as fabrication. As with University 1, University 2 explicitly prohibits uploading student work to generative AI tools. The overall tone is procedural and formal, codifying enforcement through integrity processes while leaving course-level enactment to faculty and instructional designers who align design and delivery with integrity principles in online settings.

The institutional landscape pushes toward transparent disclosure, course-level clarity about permitted AI use, protection of student data, and assessment approaches that do not depend on unreliable detection tools. Yet there is uneven specificity: some policies provide operational guidance (e.g., explicit prohibitions and disclosure expectations), while others articulate high-level principles that invite instructor interpretation. This unevenness is consequential: it shapes how instructors redesign assessments, communicate expectations, and model AI use in their own practice.

Literature Review

The rapid emergence of generative artificial intelligence has prompted higher education institutions to develop policies aimed at safeguarding academic integrity while supporting pedagogical innovation. Early scholarship emphasizes that institutional AI policies have often emerged reactively, prioritizing concerns about misconduct, plagiarism, and misrepresentation, while offering limited guidance for instructional practice (Bittle & El-Gayar, 2025; Perkins, 2023). As a result, faculty frequently navigate ambiguous expectations, interpreting policy language in ways that directly shape assessment design and teaching strategies. Several studies document how policy ambiguity influences instructor practice. Alsharefeen and Al Sayari (2025) found that faculty often view AI-related integrity policies as insufficiently operationalized, leading to inconsistent enforcement and pedagogical uncertainty. Gonsalves (2025) similarly reported that unclear AI disclosure requirements complicate assessment design and contribute to both student non-compliance and educator hesitation. These findings suggest that institutional policy does not function solely as a regulatory mechanism but actively mediates instructor decision-making around assessment transparency and instructional communication.

Research also indicates that AI policy discourse has accelerated a shift away from product-focused assessment toward process-oriented evaluation. Perkins (2023) and Bittle and El-Gayar (2025) argued that traditional assessments emphasizing final outputs are increasingly unreliable in AI-enabled environments, necessitating assessment redesign that foregrounds learning processes, reflection, and authenticity. Faculty survey research supports this shift: Bower et al. (2024) and Kim et al. (2025) reported that instructors are modifying rubrics, incorporating reflective components, and experimenting with staged submissions in response to generative AI and accompanying institutional guidance.

Beyond assessment, evolving policy has influenced educators' professional adoption of AI tools. Studies consistently show that faculty are more likely to use generative AI for planning,

feedback scaffolding, and administrative support when institutional policies move from prohibition toward conditional acceptance and ethical framing (Kim et al., 2025; Marshik et al., 2025). Chan (2023) and Lin (2025) further argued that faculty-centered policy frameworks can empower educators to integrate AI intentionally, positioning them as ethical models and designers of AI-informed learning environments rather than compliance enforcers. However, systematic reviews caution that policy development remains uneven and under-theorized (Liang et al., 2025; Qian, 2025). Much of the literature focuses on student behavior, with limited attention to how policy reshapes instructor identity, responsibility, and pedagogical agency. This gap underscores the need for self-study research examining how educators interpret and enact AI policy in context, particularly in online and asynchronous graduate education.

Methodology

The study employs a Self-Study of Teacher Educator Practices (S-STEP) design to investigate how policy developments influenced my pedagogical decisions. S-STEP is appropriate where the researcher is simultaneously the practitioner whose situated knowledge is being examined. Data sources included: (a) institutional AI policies and related integrity procedures; (b) course artifacts such as syllabi, assignment prompts, and rubrics; (c) reflective journals and analytic memos documenting teaching decisions across terms; and (d) dialogues with a critical friend to test interpretations and surface blind spots. Data collection unfolded in iterative cycles of documentation and reflection aligned with policy updates and teaching milestones. Analysis proceeded through thematic coding of journals and critical-friend transcripts, triangulated with artifacts and policy texts. Validity strategies included triangulation across sources and reflexive transparency about my positionality and decision-making. The intended outputs were a policy-to-practice mapping, principles for ethical AI integration, and practical tools for assessment redesign in online, asynchronous contexts.

Findings

Finding 1: Policy Ambiguity Functioned as a Prompt for Reflective Pedagogical Change

Early and transitional AI policies tended to be high-level, emphasizing integrity and transparency while leaving operational specifics to instructors. Instead of prescribing concrete strategies, these policies triggered sustained reflection about how to interpret “acceptable AI use” in different assessment contexts. The absence of granular direction prompted me to interrogate long-held routines: Which learning outcomes genuinely require unaided writing? Where might AI-assisted brainstorming be ethical and productive? How should I communicate permissions and boundaries without stigmatizing help-seeking? The reflective stance was catalyzed by policy ambiguity rather than by definitive rules.

The journals include questions such as, “If ChatGPT can write essays and explain complex theories, how do I ensure academic integrity in my classroom?” Rather than producing paralysis, such questions led to intentional inquiry: conducting pilots of process-embedded tasks, experimenting with staged submissions, and adding self-commentary prompts requiring students to explicate their approach and cite any AI assistance. These moves were borne not of policy mandates, but of the need to harmonize institutional principles with course realities.

Finding 2: Policy Discourse Reoriented Assessment From Product-Based Evaluation to Process-Oriented Design

In parallel with policy evolution, I observed shifts in student work, more polished, formal, and sometimes “oddly generic,” that signaled possible AI involvement. This spurred a reorientation of assessment away from product-only evaluation toward designs that make thinking visible. Concretely, I began to (a) emphasize iterative drafts with feedback checkpoints; (b) require reflective annotations in which students describe their process, including any tools (AI or otherwise) consulted; (c) incorporate oral or synchronous micro-presentations for high-stakes tasks where feasible; and (d) recalibrate rubrics to value planning, critique, and revision, not just final quality. The goal was to foreground authenticity and learning processes, aligning with institutional expectations for transparency and integrity without relying on detection tools as proof of misconduct.

This reorientation also required more explicit communication. Assignment prompts now include a course-level AI statement, permitted/restricted/prohibited, and disclosure guidance (e.g., where to describe AI use and how to cite it). Rubrics contain criteria for “Methodological Transparency” and “Reflective Rationale,” clarifying how students earn credit for metacognitive work. These adjustments shifted effort toward the *how* and *why* of knowledge construction, making misrepresentation less attractive and responsible AI use more straightforward.

Finding 3: Policy Evolution Legitimated AI as a Pedagogical and Professional Resource

As institutional documents moved from prohibition-centric language to conditional acceptance and literacy, I increasingly regarded AI as a legitimate support, particularly for educator-facing tasks. In my practice this included drafting lesson-plan outlines, generating quiz item prototypes to be vetted and revised, summarizing readings to preview for students, and composing preliminary phrasing for recommendation letters that I then personalized and validated. I adhered to policies forbidding the upload of student work to AI tools and limited AI use to materials I authored or public-domain resources. This stance, permission with guardrails, was fostered by institutional emphasis on modeling responsible use and protecting student data.

The legitimization effect mattered in two ways. First, it reduced stigma around discussing AI with students, allowing me to openly teach how to use AI tools critically (e.g., prompt literacy, bias checks, citation of AI contributions) when permitted. Second, it improved my workflow, freeing time for deeper feedback and community-building in asynchronous forums. Rather than a binary of “ban versus allow,” policy cues helped me frame AI as a tool whose value and risks depend on purpose, context, and safeguards.

Finding 4: Policy Gaps Expanded the Educator’s Role as Ethical Guide and Designer of Learning

In places where policy remained general, I assumed an expanded role as ethical guide: articulating what responsible AI assistance looks like, designing assessments that make student voice audible, and fostering a climate where disclosure is normalized rather than penalized. My communications stressed that the aim is not to resist change but to guide it—prioritizing authentic learning and protecting privacy while equipping students with AI literacy skills for professional practice. I found that centering student agency (e.g., inviting students to explain

their workflow and decision-making) both supports integrity and honors diverse pathways to mastery, particularly in international and professional programs where linguistic and cultural diversity are strengths.

Synthesis of Findings

Taken together, the findings suggest that institutional AI policies and guidelines operate primarily as catalysts rather than scripts. Their most significant impact in my context has been to spur reflective practice, accelerate assessment redesign, legitimize ethical educator use with strong data protections, and enlarge the moral and pedagogical leadership expected of instructors. In asynchronous, pre-created course environments, where the curriculum is relatively fixed, the locus of agency shifts to *how* we frame expectations, scaffold processes, and evaluate learning. Policy can set boundaries, such as prohibiting uploads of student work to public models and insisting on disclosure, but the practical architecture of authenticity is designed at the course level.

This synthesis also underscores tensions. First, ambiguity can be productive for innovation but burdensome for consistency: instructors may interpret disclosures, permissions, and assessment redesign differently across sections or programs. Second, integrity enforcement that relies on detection technologies risks false accusations; thus, institutional cautions against sole reliance on detectors push us toward pedagogy-first solutions that embed process evidence and reflective rationales. Third, legitimizing educator use raises equity considerations: if AI accelerates some tasks, do we reallocate the recovered time to higher-touch feedback and community-building? The answer in my experience is yes—but only if such reallocation is designed into workload expectations and supported by professional development.

Finally, the synthesis highlights a throughline Transparent course-level statements about AI permissions, transparent rubrics that reward process, and transparent educator modeling of ethical AI use collectively cultivate a culture where disclosure is expected and safe. This cultural work is especially crucial in graduate online settings, where asynchronous modalities can obscure process and make product-only assessments vulnerable to misrepresentation.

Next Steps

Building on these insights, my immediate and medium-term priorities include four strands of work:

1. Sustain the S-STEP with Critical-Friend Dialogue. I will continue cycles of planning, acting, observing, and reflecting, supplemented by critical-friend reviews of artifacts and coded reflections. This will help test emerging principles against new cohorts, policy updates, and course contexts, ensuring that practice evolves with evidence rather than anecdote.
2. Attend to Socio-Cultural Dimensions, Including Indigenous Education and International Student Experiences. I will examine how AI permissions and literacies intersect with Indigenous pedagogies, cultural protocols, and community accountability, resisting a one-size-fits-all frame. For international students, I will consider language support, genre expectations, and cross-cultural understandings of authorship, designing disclosures and reflection prompts that invite culturally responsive articulation of process and collaboration.
3. Advance Applications for Asynchronous, Fixed-Curriculum Courses. Within the constraints of pre-built shells, I will develop: (a) staged assignments with reflective

- checkpoints; (b) optional oral defenses or mini-presentations for capstone tasks; (c) formative AI-literacy micro-activities (e.g., bias audits, prompt revision exercises) when permitted; and (d) feedback templates that encourage students to respond and iterate, keeping the instructor's human presence salient in self-paced environments.
4. **Monitor and Map Policy Developments to Course-Level Guidance.** I will track institutional and external AI guidelines and translate updates into concise course statements and rubrics. I will also maintain a living repository of disclosure exemplars and citation practices (e.g., where to acknowledge AI assistance in APA style), revising as standards evolve. Particular attention will remain on data privacy: never uploading student work to AI systems, even for formative purposes, and providing safe alternatives for skill-building.

Conclusion

In rapidly evolving AI-mediated educational contexts, institutional policy does not dictate practice so much as provoke reflective inquiry and ethical decision-making at the instructor level. This self-study demonstrates that when educators engage policy critically, they can redesign assessment, model transparency, and integrate generative AI in ways that foreground authentic learning rather than procedural compliance. As AI continues to reshape graduate education, sustained practitioner reflection and context-sensitive interpretation of policy will remain essential to preserving academic integrity, equity, and educator agency.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

Artificial intelligence (AI) tools were used in a limited and transparent manner in the development of this manuscript. AI-assisted writing tools (including Microsoft Copilot) were used to support early drafting and language refinement of selected sections based on researcher-provided prompts. Generative AI tools (including Claude AI) were used to assist with preliminary qualitative coding and thematic organization of reflective journals and critical friend dialogue transcripts; all coding and interpretations were subsequently reviewed, refined, and validated by the researcher. AI-supported tools were also used to facilitate the identification of relevant peer-reviewed literature, with all sources independently verified through academic databases and publisher websites prior to inclusion. No student work or confidential data were uploaded to any AI system. All AI-generated content was critically evaluated, edited, and integrated by the author, who assumes full responsibility for the analysis, interpretations, and final manuscript.

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Plural Pedagogies and Inclusion in French Primary Schools: Building Teacher Self-Efficacy

Kari Stunell, Université de Bordeaux, France

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Abstract

The domain-specific nature, and the organisational, instructional and emotional components of teacher self-efficacy have been widely explored in research in education for over 40 years. This presentation examines teacher self-efficacy in relation to the use of plural approaches to the inclusion of plurilingual and pluricultural pupils in French primary schools. Navigating the mismatch between the values, rules, beliefs and linguistic expectations of home and school can be challenging for this group of pupils, who require high levels of self-efficacy, which positively impacts resilience, persistence and willingness to try hard, if they are to succeed. Recent research highlights links between high teacher self-efficacy, the development of high pupil self-efficacy, and the use of inclusive classroom practices. This paper investigates the extent to which the experiences of future primary-school teachers in France during their periods of teaching practice are likely to contribute to the development of high levels of self-efficacy in relation to the use of plural pedagogical practices. Data was collected from 300 student-teachers enrolled in a two-year pre-service teacher education programme using an online questionnaire and follow-up interviews which examined their self-efficacy feelings in relation to plural classroom practices, and their enactive and vicarious experiences of these practices during teaching practice. The results suggest that despite some positive points, overall exposure to language awareness activities during teaching practice is not systematic enough to really impact the evolution of high TSE in this domain. The findings have important implications for the content of the pre-service teacher education programme.

Keywords: teacher education, primary school, plurilinguism, plural pedagogies, language teaching

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Introduction

UNESCO statistics concerning the French school system reveal a significant level of linguistic and cultural diversity within the pupil population. In 2024 a third of school pupils surveyed, so about four million children, claimed they spoke a language other than French, (the language of schooling), at home. Statistics published by the French government show that 88,500 allophone children were registered in the school system in the year 2023–2024. France has a republican school system born with the education reforms of Jules Ferry in 1881 and 1882. The underlying motivation for these reforms was a vision of education as a tool for reenforcing nationhood, and creating social justice and equality. This was to be done through rigorous, moral, civic education in one shared language for all future citizens. At the heart of the project was the desire to create a more unified society and within this view, having a shared language and culture was seen as being particularly important. Therefore, a clear division between the public and private spheres, so here school and home, was promoted. In order to achieve this, socio-culturally specific characteristics, such as signs of religious affiliations, or languages other than French, were to be left at the door, thus ensuring a level playing field for all pupils. The consequences of these reforms and the vision of society and education which underpinned them can still be felt in today's schools. The education system is highly centralized, secular, places a very high value on mastery of the French language, and has an additive approach to the acquisition of languages other than French. Foreign languages are seen as school subjects and not as tools for life and living, and heritage languages are viewed as belonging to the private sphere and therefore not as needing a place in schools.

However, nowadays, this vision, created to promote equality, seems to be at odds with modern scientific research in plurilinguism and identity construction. Research in plurilinguism (Choi & Ollerhead, 2018; Coste et al., 2009; Garcia & Li, 2014; Piccardo, 2019), views a person's repertoire of languages as a single, composite competence within which languages are in constant interaction. Research into identity (Lau, 2020; Norton, 2013), views language and culture as being intrinsic to, and inseparable from, a person's ongoing process of identity construction. How then can a child be expected to be able to leave their linguistic and cultural diversity at the door of the school and still have the same school experience as a pupil who does not experience any linguistic or cultural dissonance between home and school? This research project investigates this apparent tension between the republican school system and the linguistic and cultural reality of the current pupil population from the perspective of future teachers within the system – student teachers, currently engaged in initial teacher education in France, who were for the most part themselves educated within this same school system. How do they feel about their capacity to manage the possible conflicts they may find between their own education, the cultural history of the school system, current research in plurilinguism and the situation they find in their own classrooms? Has does managing this complexity effect their feelings of self-efficacy concerning the use of plural approaches to linguistic and cultural diversity in the classroom?

Literature Review

Bandura (1977, 1997), defined self-efficacy in terms of an individual's own perception of their ability to act effectively in a given situation. Despite not being directly based on actual capacity, self-efficacy beliefs have consistently been shown to have a positive impact on a person's persistence when confronted with difficulties, their readiness to make an effort, their resilience, and their confidence when confronted with challenges that demand creative

solutions (Pajares & Schunk, 2001; Tschannen-Moran & Hoy, 2001; Woodcock et al., 2022). Bandura identified four main aspects which contribute to the evolution of a person's self-efficacy beliefs - previous experiences of mastery, enactive experiences, social interactions such as criticism, advice, or praise, and previous emotional reactions such as feelings of inadequacy or incompetence. Teacher self-efficacy (TSE) has attracted much attention in research in education over the last forty years (Zee & Koomen, 2016). The challenging and constantly-evolving nature of teaching and learning situations means that effective teachers need high levels of adaptability, willingness to try new solutions, and persistence in the face of challenges. Research has shown however that TSE is task-specific, a particularly important point for teacher educators to bear in mind. A teacher may have a high level of TSE in one domain, with one age-group, with a certain type of pupil population, or with certain methodologies, but not with others. Teacher educators therefore need to identify specific areas within which teachers experience low TSE and accompany them in working on the instructional, organisational and emotional competences (Woolfolk-Hoy et al., 2009) needed in those areas.

Given the mismatch between the cultural and linguistic make-up of the current pupil population in French schools and the traditions on which the republican school system is founded, it seems likely that the domain of classroom practices which promote the inclusion of linguistic and cultural diversity within the teaching would be one in which student-teacher feelings of self-efficacy are not highly evolved. Quite a body of research nonetheless points to the importance and positive impact of high TSE in relation to inclusive teaching practices in areas such as attitudes to pedagogical innovation (Eun & Heining-Boynton, 2007; Lidner & Schwab, 2020; Woodcock, 2022), willingness to differentiate and provide scaffolding for struggling students (Hamre & Pianta, 2010), ability to connect to students' lives (Thoonen et al., 2011), willingness to provide emotional support (Hamre & Pianta, 2010), and attention to building a supportive classroom climate (Buric & Kim, 2020).

Research also suggests that teacher self-efficacy and pupil self-efficacy are linked. Plurilingual and pluricultural pupils dealing with a mismatch between the rules, behaviours, and language use expected at home and at school (Chapellon & Gontier, 2015) and the frustrations this can bring also need high levels of self-efficacy (Peetsma et al., 2005). Teachers who support the development of plurilingual competences, consider the relationships between pupils' interior lives and their felt sense of access to the learning, and who work on creating a social environment which optimises linguistic and cultural inclusion, are likely to positively impact the self-efficacy feelings of plurilingual and pluricultural pupils (Ross et al., 2001; Thoonen et al., 2011; Usher et al., 2023).

Methodology

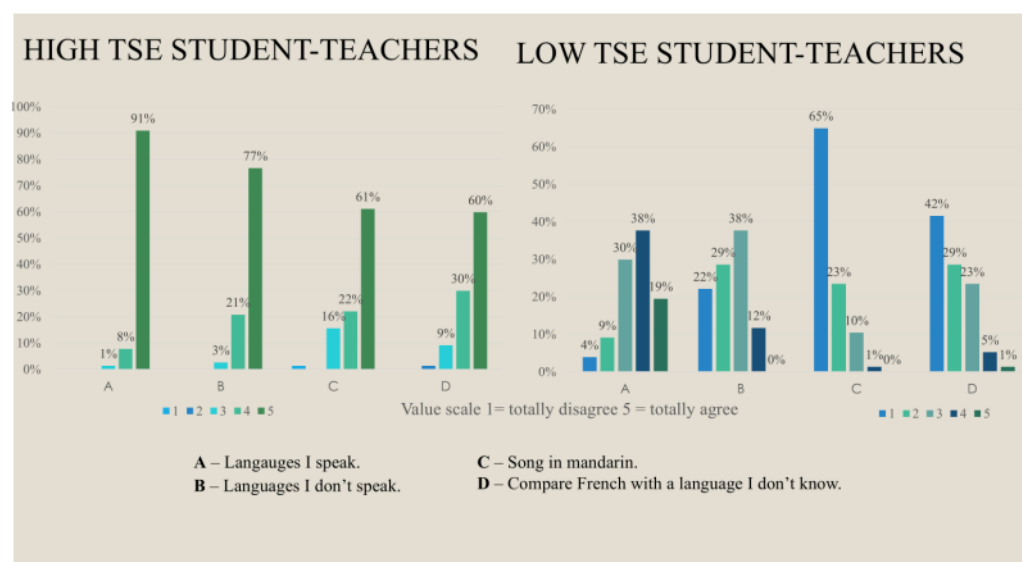
The 301 participants in the current study were all enrolled in a two-year pre-service teacher education degree at masters' level, in a French university. This first phase of data collection involved completion of an online questionnaire which the participants completed at the beginning of the academic year. The questionnaire included open questions and statements to which the participants were asked to mark their level of agreement using a *Likert* scale. The questions focused on the student-teachers' perceptions of plurilinguism, their own and their pupils, and on their experiences with, and confidence to employ, plural pedagogies in the primary school classroom. As a second step, follow up interviews were conducted at the end of the academic year. In the current article we examine responses to four questions related to the participants' estimations of their self-efficacy in reference to plural classroom practices.

Results

Using a *Likert* scale from 10 (high level of confidence) to 1 (low level of confidence), the participants indicated their level of confidence in relation to the four following statements: “I could explore languages I know with my pupils”, “I could explore languages I don’t know with my pupils”, “I could accompany a pupil in making comparisons between French and another language which the pupil knows, but which I don’t know myself”, and “I would feel at ease listening to a song in Mandarin with my pupils”. Their responses were used to calculate their level of TSE from a maximum of 40 to a minimum of 1. The following graph relates the self-efficacy feelings of the most confident 25% of the cohort and the least confident 25% of the cohort in relation to each of the four statements.

Figure 1

Student-Teacher Responses to Four Questions Concerning Self-Efficacy Feelings in Relation to Plural Classroom Practices



The first two statements, concerning the participants’ level of confidence in exploring languages generally with their pupils, already reveal the probable impact of self-efficacy feelings on classroom practices. Those in the high TSE group would feel confident working with both known (99% give a score of 7 to 10 to this proposal) and unknown (98% give a score of 7 to 10 to this proposal) languages with their pupils – even though only 77% feel fully confident (score or 9–10) where unknown languages are concerned, as opposed to 91% for known languages. These figures contrast with the situation for the low TSE group. Here just over half (57%) feel confident where known languages are concerned and only 12% when it comes to unknown languages. Of the remaining participants in this group, 22% feel a total lack of confidence in this domain and a further 29% feel unsure of their capacity. The high TSE group remain confident when asked to think about more specific classroom situations, such as exploring a song in Mandarin (where 61% feel fully confident and a further 22% quite confident), or helping a child to compare French with a language which the child knows but which the student-teacher doesn’t know (60% feel fully confident and a further 30% quite confident). In contrast the low TSE group do not see themselves as capable of managing this kind of task effectively. Only 12% feel quite confident (score of 7–8) about listening to a song in Mandarin with their pupils and 6% feel fully confident (1%), or quite confident (5%) in leading comparisons between French and other unknown languages.

Discussion

Since research has repeatedly shown clear links between teachers' felt sense of self-efficacy and their actual classroom action in terms of goal-setting, willingness to experiment with new pedagogies, persistence in the face of challenging teaching situations, and willingness to recognize the links between pupils' interior worlds and their outward learning capacities, these results give food for thought for teacher educators. For example, within the group with lower TSE, 22% feel very unconfident and 29% unsure, when it comes to exploring languages which are unknown to them, with their pupils. However, in the majority of cases, pupils' heritage languages are unknown to their classroom teachers. Furthermore, research in the field of identity construction clearly underlines the key role of languages in this process. In order for plurilingual children to feel fully accepted in the classroom their languages need to be valorized and authorized and given a role within the learning. The results show that even within the group of student-teachers with a higher level of TSE, their level of confidence decreases in response to the questions which make more concrete pedagogical propositions. Whilst 77% feel very confident exploring unknown languages and only 3% unsure about doing this, only 60% actually feel fully confident when it comes to helping a pupil to compare a language which the teacher doesn't know with French, and 9% actually feel unsure about doing this. Similarly, listening to a song in Mandarin would leave 65% of those with low TSE feeling uncomfortable, and 16% of those with high TSE feeling unsure. Yet songs are a key teaching tool at primary level and a relatively simple way to introduce cultural diversity into the classroom, since they marry the more universal and recognizable language of the music with the less comprehensible linguistic aspect. Songs which come from the heritage cultures of the pupils are an effective way of opening positive debate and sharing around pupils' cultural diversity. According to this brief presentation of student-teacher responses to these four questions, how far can these student-teachers be expected to give heritage languages and cultures a place in the learning in their classrooms when they become qualified teachers?

Conclusion

Despite the limits of the study as presented here, since only the responses to four the questionnaire questions are analyzed in detail, nonetheless, this study has clear implications for teacher education. Managing linguistic and cultural diversity in the classroom is always going to be challenging for both teachers and pupils. From the pupil perspective, not being able to follow the content of the classes due to difficulties with the language of schooling, which come not from a lack of linguistic competence, but rather from having competences in a language or languages which are not recognized in the classroom is bound to be frustrating. For teachers, trying to help children competent in languages of which the teachers themselves have no knowledge, is likely to be daunting and demands new approaches and specific tools. High levels of teacher and pupil self-efficacy, which lead to increased persistence, resilience, and willingness to expend effort and to experiment with creative solutions, seem key to overcoming the challenges inherent in the situation, leading to a transformation of obstacle-oriented perceptions of classroom diversity, to perceptions of classroom diversity as a rich resource of learning for all pupils. If this is to happen, both initial teacher education programs and ongoing professional development programs have an important role to play in providing future teachers with positive experiences of plural pedagogies both as enactive and vicarious experiences. This can be achieved through work to familiarize both student-teachers and classroom professionals with a range of resources concerning plural approaches to languages in the classroom, accompanied by reflection as to the role these activities can play in

increasing pupil self-efficacy, school readiness and reducing home-school dissonance. Student-teachers also need opportunities to observe effective plural practices in the classrooms of expert teachers during their periods of teaching practice in order for them to feel prepared to meet the linguistic and cultural diversity in their own classrooms with confidence.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that no AI or AI-assisted technologies have been used to generate, refine, or correct the content in the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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