Design and Preliminary Evaluation of an Interactive Form Technology-Based Escape Room Music Learning Game With Contextual Spatial Clues Exploration

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Abstract

Lecture-based music teaching is often characterized by low student motivation and insufficient participation in the classroom, reflecting the difficulty in stimulating interaction and enthusiasm. Game-based learning can help to overcome these limitations of low motivation and low interaction, but it still faces the challenge of insufficient contextualization. In this study, we used Google Forms platform to develop an educational game called "The Sound of Your Presence," which was designed to build a realistic castle space for players to explore and embedded digital tools such as an online virtual musical instrument and Google Chrome Music Lab to assist players to enhance their listening skills while exploring the castle and listening to melodic music. In addition, e-books are used as scaffolds to provide timely knowledge of music history and theory. Players can explore and analyze the music in the game. The participants in this study were 40 Taiwanese high school students. The study measured the students' flow, acceptance, and cognitive load. It was found that the learners had a high level of flow and acceptance of the game; they did not have a high intrinsic and extrinsic cognitive load, and had a moderate germane cognitive load, which indicated that the game was effective in facilitating the players' thinking. In the qualitative survey, more than half of the learners mentioned that games can stimulate the learning experience, and more than thirty percent of them said that the clues and scaffolding e-books provided in the games can help them learn more about music.

Keywords: music game-based learning, situated learning, scaffolding

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Introduction

In high school music classrooms, adolescents often experience reduced engagement due to boredom and distraction from mobile phones (Arnett, 1991). Despite diverse course content, abstract classical music and specialized terminology disconnected from daily life create significant barriers to comprehension and immersion, thereby undermining learning motivation and classroom interaction (McLeod & Becker, 1981; Palmgreen, 1984).

To bridge cognitive and emotional needs, appropriate scaffolding strategies reduce cognitive load. Music listening exercises employ score analysis and task decomposition (guiding students to first discern musical melodies before understanding harmonic progressions in accompaniment), layered instruction (supported by digital music technology platforms), and real-time prompts (e-book or question guidance) can be scaffolding strategies. This multi-modal integration of visual, auditory, and kinesthetic channels reduces cognitive load while enhancing auditory discrimination and music theory comprehension, thereby boosting learning motivation and situational engagement (Chandler & Sweller, 1991; Kuo & Hou, 2025; Lavy, 2023; Moreno & Mayer, 2000; Sai, 2024; Zhang, 2025).

Scenario-based simulation learning emphasizes student-centered motivation and emotional needs. This study employs a triple simulation mechanism of "story, space, and character" to design the educational game "Music with You" using Google Forms. This game features scenario exploration environments. During puzzle-solving, learners freely explore visual representations of the castle space. This immerses learners in the game's interactivity and fun while progressing through levels, aiming to simultaneously boost self-efficacy and learning motivation, reduce anxiety, enhance flow experiences, and ultimately improve learning outcomes (Chien et al., 2023; Csikszentmihalyi, 1990).

To address the abstract nature of music theory concepts, this study employs scaffolding theory as the core design framework for scenario-based game learning. Within educational games, multidimensional scaffolding effectively promotes knowledge application and overall learning outcomes (Chien et al., 2023; Csikszentmihalyi, 1990; Hou & Chou, 2012; Hou & Li, 2014). To support the learning process, this study employs an e-book integrated with clue inference mechanisms as an immediate knowledge guidance scaffold, providing timely prompts and task decomposition. It further incorporates digital tools such as the online virtual instrument Mussica and Google's Chrome Music Lab to enhance auditory discrimination skills, promote cognitive construction of auditory perception and music theory, and systematically reduce cognitive load through layered scaffolding design. seamlessly elevating auditory discrimination and music theory cognition to achieve classical music appreciation objectives.

Research Purposes and Questions

This study aims to design and evaluate an educational game operating on Google Forms. The game integrates two technological music platforms—*Mussica* and *Chrome Music Lab*—to enhance its visualization and concreteness. Additionally, it incorporates spatial scenes of 17th-18th century castles simulated through forms and generative AI images for learners to explore. An e-book provides scaffolding cues for real-time guidance. These designs aim to overcome challenges common in traditional lecture-based classical music appreciation, such as insufficient contextual authenticity, limited interactive time, and venue constraints. Through spatial exploration via contextual Google Forms, multimedia materials, and scripted form

interaction paths, learners enhance their comprehension of abstract classical music theory and increase learning motivation.

The research questions are: First, can the music-themed escape room game utilizing spatial exploration and form technology enhance learning flow? Second, what is the game's acceptance level based on its design? Third, how can cognitive load in learners be assessed within educational games?
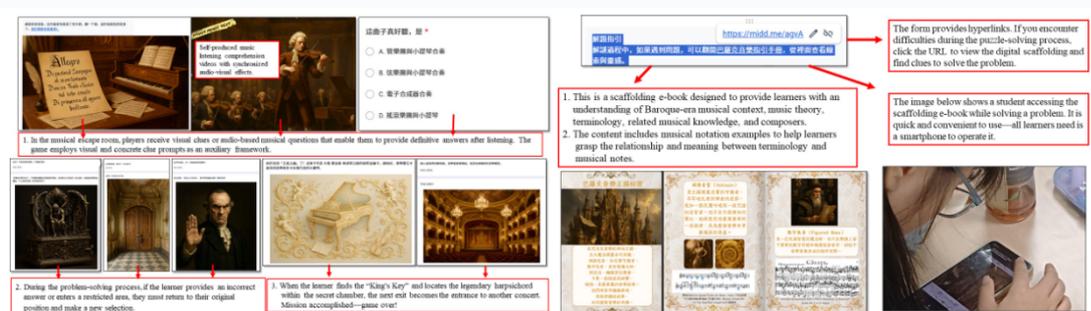
Methods

This study was preliminarily tested through case analysis, involving 40 participants (20 male, 20 female) from two classes of Taiwanese high school students, with 20 students per class and equal representation of genders.

This music education game, titled "*The Sound of Your Presence,*" utilizes Google Forms as its operational platform. It employs AI-generated imagery to recreate Baroque-era historical facts from the 17th to 18th centuries, simulating period-specific narratives, characters, settings, and environments. All operational details are centered on the 1600–1750 (Fiorentino, 2023) timeframe (Figure 1). Titled "*The Sound of Your Presence,*" this educational game centers on an antique harpsichord crafted by Scarlatti himself, which can only be unlocked and played using the "*King's Key.*" During problem-solving, students may consult an e-book for clues to find answers (Figure 2).

Figure 1

Generated AI Realistic Scenes Enhance the Immersive Fidelity and Presence of the Gaming Experience

Figure 2

Learners Engage in Game-Based Problem-Solving Through Coordinated Audiovisual Design, Utilizing the Scaffolding E-book as a Reference Resource for Clues and Answers

The research methodology employed three scales to measure students' flow, game acceptance, and game elements alongside cognitive load. The learning process comprised game instructions 10minutes), game activities(25minutes), and questionnaires on flow, acceptance, and cognitive load (15 minutes).

The flow questionnaire utilized the Kiili Flow Questionnaire (2006), translated and revised by Hou and Li (2014). This scale encompasses Flow Antecedents and Flow Experience, scored on a 5-point Likert scale. The 22-item questionnaire demonstrated high internal consistency (Cronbach's alpha = 0.98).

To assess learners' acceptance of games, the Game Acceptance Scale measures two sub-dimensions: Game Feedback and Game Elements, comprising 12 items. Adapted from Davis's (1989) Technology Acceptance Model, the Game Feedback Scale includes Cognitive Usefulness and Cognitive Ease of Use, totaling 7 items. Additionally, drawing from game motivation factors proposed by Chan et al. (2024), Chien et al. (2023), and Hou and Chou (2012), a game elements scale was developed, comprising five items. Both scales employed a five-point Likert scale for assessment. The internal consistency reliability for game acceptance was Cronbach's alpha = 0.98; for game feedback, Cronbach's alpha = 0.99; and for game elements, Cronbach's alpha = 0.95. All measurements demonstrated high internal consistency reliability.

The cognitive load scale was developed based on Leppink et al. (2013) and adapted from Klepsch et al. (2017). It comprises three dimensions with 8 items: extraneous cognitive load (3 items), assessing cognitive load arising from learning activity design or methods that fail to facilitate learning; and germane cognitive load (3 items), measuring the extent to which learning content helps learners establish metacognitive schemas and promotes reflection. All questionnaires employed a 5-point Likert scale, with internal consistency reliability (Cronbach's alpha) of 0.87.

Results and Discussions

The study measured students' flow, game acceptance, and cognitive load using scales. Results revealed that learners' descriptive statistics showed an overall flow mean of M = 3.69, standard deviation SD = 0.94 (Table 1); game feedback mean of M = 3.80, standard deviation SD = 0.94; and game elements mean of M = 3.76, standard deviation SD = 0.87 (Table 2). Following a one-sample t-test, the study found that the overall flow mean and all flow sub-dimensions, as well as game acceptance feedback, were significantly higher than the scale median (i.e., 3). This indicates that learners possess a moderately high level of flow experience, exhibit high flow during gameplay, and demonstrate high game acceptance.

Table 1
The Mean and Standard Deviation of Learners' Flow (N = 40)

	M	*SD*	*t*	*p*
Overall Flow	3.69	0.94	4.62***	< .001
Flow antecedents	3.67	0.96	4.41***	< .001
Flow experience	3.70	0.93	4.72***	< .001

Note. ***$p < 0.001$

Table 2
The Mean and Standard Deviation of Learners' Game Feedback, and Game Elements (N = 40)

	M	SD	t	p
Game Feedback	3.80	0.94	5.34 ***	< .001
Game Usefulness	4.45	0.61	5.38 ***	< .001
Game Ease of Use	4.56	0.67	5.06 ***	< .001
Game elements	3.76	0.87	5.46 ***	< .001

Note. ***$p < 0.001$

Regarding the descriptive statistics of cognitive load, the mean value for intrinsic cognitive load was M = 3.47 with a standard deviation SD = 0.92; The mean for extrinsic cognitive load was M = 3.16, with a standard deviation SD = 1.07; the mean for generative cognitive load was M=3.26, with a standard deviation SD = 0.89. Results from the one-sample t-test indicated that intrinsic cognitive load was significantly higher, while extrinsic cognitive load during gameplay showed no significant difference. For generative cognitive load, M = 3.26, SD = 0.89, t-test = 4.20, highly significantly exceeding the median of 3, indicating that music education games effectively enhance players' cognitive learning through thinking (Table 3).

Table 3
The Mean and Standard Deviation of Learners' Cognitive Load (N = 40)

	M	SD	t	p
Intrinsic cognitive load	3.47	0.92	3.19**	0.003
Extrinsic cognitive load	3.16	1.07	0.93	0.356
Germane cognitive load	3.26	0.89	4.20***	< .001

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

In the qualitative survey, regarding learning motivation, 57.5% of learners reported that the game was highly engaging, effectively stimulating their motivation to learn, and providing an excellent, enjoyable experience. Regarding game acceptance, 30% of learners reported that this teaching method was unique, allowing them to use mobile phones and the internet to look up information, solve problems, and enhance memory, making the class innovative and fun. Regarding the scaffolding e-book teaching aid, 35% of learners reported learning a lot of knowledge through fun games, and that the game manual also provided valuable learning through reading. 25% of learners reported acquiring relevant musical terminology, music styles, music theory, and knowledge of various instruments through the game.

Conclusions and Limitations

This study developed a music education game titled "*The Sound of Your Presence*," using Google Forms to design a castle-themed spatial visualization. Preliminary results indicate that the design of a music-themed escape room game utilizing spatial exploration and form technology enhances learners' flow state, acceptance, and provides appropriate cognitive load during the learning process. Future research could expand the sample size and incorporate AI-powered online interaction as scaffolding. This would enable a comprehensive comparative analysis of how integrating AI as a teaching assistant within the same online game design affects flow, cognitive load, learning outcomes, scaffolding effectiveness, and perceived realism.

Funding

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