The Young Botanists Club: A Model for Blending Science, Life Skills, and Joyful Learning

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Abstract

This study explores the design and implementation of weekly extracurricular activities conducted by the Young Botanists Club in a laboratory school setting. Conducted twice a week after school, the program integrates botanical knowledge with interdisciplinary learning experiences, including cooking, digital technology, home economics, creative arts, and entrepreneurship. Activities were thematically diverse and tailored to students' interests, school priorities, and relevant and contemporary issues. The research employed student and parent questionnaires alongside in-depth interviews to investigate participants' perceptions and experiences. Results revealed that elementary school students particularly valued cooking-related activities, citing enjoyment, experimentation, and the tangible outcome of their efforts. These experiences not only enhanced practical skills but also offered potential vocational relevance. Moreover, students consistently reported that the varied nature of each session fostered continuous engagement, personal development, and new social connections. The presence of expert guest speakers further enriched the learning process. Overall, the Young Botanists Club effectively bridged scientific concepts with everyday life, offering an exemplary model for holistic, interest-driven education that cultivates both knowledge and essential life skills

Keywords: extracurricular learning, interdisciplinary education, primary school students, experiential learning, student engagement

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Introduction

In recent years, education has increasingly emphasized the development of learners who possess not only academic knowledge but also essential life skills, adaptability, and lifelong learning abilities. Traditional classroom instruction alone is often insufficient to address these complex demands, particularly at the primary level where holistic development is crucial. Therefore, educational approaches that integrate cognitive, social, and emotional dimensions have become increasingly important. Research suggests that meaningful learning experiences should connect knowledge with real-life contexts and support the overall development of learners (Darling-Hammond et al., 2020). As a result, schools are encouraged to design learning environments that extend beyond conventional classroom settings.

Contemporary education also highlights the importance of active and student-centered learning approaches that encourage participation and real-world application. Such approaches enable students to engage more deeply with content and develop transferable skills necessary for the 21st century. Global educational perspectives emphasize competency-based learning, where knowledge, skills, and values are integrated to prepare students for future challenges (OECD, 2020). Learning environments that promote hands-on activities and real-life connections are therefore essential in fostering meaningful and effective learning experiences.

Student engagement is widely recognized as a critical factor influencing learning outcomes. Engaged students are more likely to participate actively, demonstrate persistence, and achieve better academic performance. Engagement is shaped by the relevance and diversity of learning activities, as well as the extent to which students find the learning process meaningful. Recent studies indicate that engagement is a multidimensional construct that includes behavioral, emotional, and cognitive components (Fredricks et al., 201). Furthermore, the development of students' interest plays a significant role in sustaining long-term engagement and motivation in learning. According to the four-phase model of interest development, learners gradually develop interest through structured and meaningful experiences. These findings emphasize the importance of designing student-centered learning experiences that align with learners' interests and needs.

In response to these perspectives, the Young Botanists Club was developed as an extracurricular program that integrates botanical knowledge with student-centered and real-world learning experiences in a laboratory school context. The program provides primary school students with opportunities to engage in a variety of hands-on activities, such as cooking, digital technology, creative arts, and entrepreneurship, all of which are connected to real-life applications. By linking scientific concepts with everyday experiences, the program aims to promote both academic understanding and essential life skills. Therefore, this study aims to explore the design and implementation of the program and to examine students' and parents' perceptions of its outcomes. The findings are expected to contribute to the development of effective models for holistic, interest-driven education.

Research Objectives

This study aims to examine the design and implementation of extracurricular activities conducted by the Young Botanists Club to ensure they are engaging, enjoyable, and beneficial for primary school students. It focuses on integrating interdisciplinary and experiential learning within a laboratory school context, connecting students' interests with real-life applications. The study also proposes a model for organizing activities that promote engagement and holistic

development. It seeks to answer how activities should be designed to be engaging and beneficial, and what outcomes they produce for students.

Literature Review

Botanical Learning and the School Botanical Garden Concept (Rewritten)

Botanical learning plays a significant role in enhancing students' understanding of plant science, environmental awareness, and sustainable living. In primary education, learning about plants extends beyond theoretical knowledge to include hands-on experiences that enable students to connect scientific concepts with real-life contexts. School botanical gardens are widely recognized as effective learning environments that support inquiry-based and student-centered learning. These spaces provide opportunities for students to observe plant growth, explore biodiversity, and develop responsibility through direct interaction with nature. Previous studies have shown that garden-based learning can improve students' scientific understanding, environmental awareness, and practical skills (Ohly et al., 2016; Soga et al., 2017). In addition, such environments promote interdisciplinary integration by linking science with other subjects, including art, health, and social studies. Therefore, botanical learning combined with the school botanical garden concept offers a meaningful approach to fostering holistic and sustainable education.

Extracurricular Activities and Holistic Student Development

Extracurricular activities play a crucial role in promoting holistic student development beyond academic achievement. These activities provide opportunities for students to develop social, emotional, and practical skills through active participation in diverse learning experiences. Research indicates that participation in extracurricular programs is associated with improved academic performance, enhanced self-confidence, and stronger interpersonal skills (Eccles & Barber, 1999; Fredricks & Eccles, 2019). Moreover, such activities encourage collaboration, responsibility, and leadership, which are essential competencies for lifelong learning. Holistic development is further supported when extracurricular programs are aligned with students' interests and real-life contexts, fostering both intrinsic motivation and sustained engagement. Recent studies also emphasize that well-structured extracurricular activities contribute to students' well-being and overall development by integrating cognitive, emotional, and social dimensions (Darling-Hammond et al., 2020). Therefore, extracurricular learning environments serve as an important platform for nurturing well-rounded individuals who are prepared for future challenges.

Interdisciplinary Learning and Life Skills Development (Final Clean Version)

Interdisciplinary learning plays a significant role in developing essential life skills among students in the 21st century. By integrating knowledge across multiple subject areas, learners are able to construct deeper understanding and apply concepts to real-world situations. This approach promotes critical thinking, creativity, and problem-solving, which are key competencies for lifelong learning. Interdisciplinary learning environments encourage students to connect ideas across domains, fostering meaningful learning experiences and deeper engagement. In addition, such approaches promote collaboration, communication, and adaptability, as students participate in activities that require teamwork and active involvement. These experiences contribute to the development of life skills necessary for personal and social growth. Furthermore, educational approaches that integrate cognitive, social, and emotional

dimensions can enhance students' overall development and learning outcomes (Darling-Hammond et al., 2020). Recent research also highlights the importance of teaching transferable skills through integrated and applied learning experiences (van Laar et al., 2020). Therefore, interdisciplinary learning provides an effective framework for fostering both academic achievement and holistic life skills development.

Interest-Driven and Joyful Learning (Updated Version)

Interest-driven and joyful learning plays a crucial role in enhancing students' motivation, engagement, and overall learning outcomes. When learning activities align with students' interests, they are more likely to participate actively and sustain attention over time. Such learning environments encourage curiosity, exploration, and intrinsic motivation, which are essential for meaningful learning. Research suggests that positive emotions in learning, such as enjoyment and interest, significantly influence students' cognitive processes and academic performance (Pekrun et al., 2017). In addition, self-determination theory highlights the importance of intrinsic motivation in fostering sustained engagement and effective learning (Ryan & Deci, 2020). Joyful learning experiences also help reduce anxiety and create a supportive environment where students feel comfortable expressing their ideas and taking risks. Furthermore, interest-driven learning promotes deeper understanding, as students are more willing to invest effort in activities that they find meaningful. It also contributes to long-term motivation and the development of lifelong learning habits. Therefore, designing learning activities that are both engaging and enjoyable is essential for supporting students' holistic development.

Learning With Experts and Community Participation

Learning with experts and community participation plays a vital role in enriching students' learning experiences and connecting classroom knowledge with real-world applications. Interaction with experts allows students to gain authentic insights, practical knowledge, and exposure to real-life problem-solving processes. These experiences help bridge the gap between theoretical understanding and practical application, making learning more meaningful and relevant. In addition, community participation promotes collaborative learning and encourages students to develop a sense of social responsibility. Engaging with external partners also enhances students' communication, critical thinking, and adaptability skills, as they interact with individuals from diverse backgrounds. Research indicates that learning environments involving real-world collaboration and community engagement can significantly improve student motivation and learning outcomes (Darling-Hammond et al., 2020). Such experiences support both personal and social development through active participation and contextualized learning. Therefore, integrating experts and community resources into educational activities provides an effective approach to fostering holistic and meaningful learning.

Conceptual Framework

By addressing these research questions, this study contributes to the growing body of knowledge on extracurricular learning and its potential to enhance the development of primary school students. The findings provide practical insights for designing activities that are engaging, enjoyable, and beneficial for learners. Furthermore, it is important to explore how the Young Botanists Club can be effectively implemented in a laboratory school context to support meaningful learning experiences and meet the diverse needs of students. The

conceptual framework developed by the researchers presents the independent variable (IV), namely the Young Botanists Club activities, and the dependent variables (DV), including the design of activities that are engaging, enjoyable, and beneficial, as well as the outcomes of these activities for students, as illustrated in Figure 1.

Figure 1
Conceptual Framework of the Study

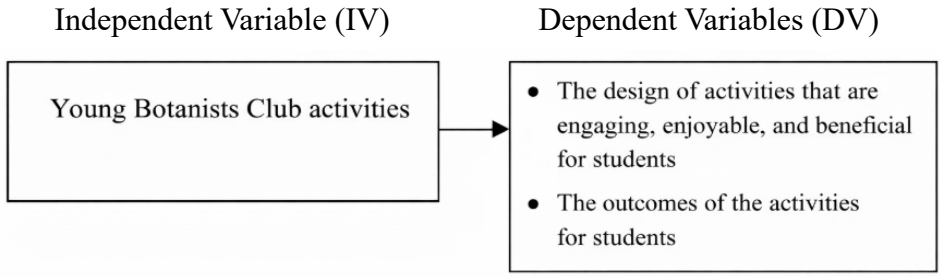

Figure 1 illustrates the conceptual framework of this study, which examines the implementation of the Young Botanists Club and its impact on student development. The framework consists of independent and dependent variables, where the Young Botanists Club activities serve as the independent variable, while the design of activities that are engaging, enjoyable, and beneficial, as well as the outcomes of these activities for students, represent the dependent variables. The framework emphasizes how well-designed extracurricular activities can enhance students' learning experiences and contribute to their overall development. It highlights the relationship between activity design and student outcomes, demonstrating how meaningful and interest-driven activities can foster engagement, skill development, and positive learning experiences among primary school students.

Method

Research Design

This study employed a descriptive research design to examine the design and implementation of extracurricular activities conducted by the Young Botanists Club in a laboratory school setting. The activities were organized once or twice a week after school, integrating botanical knowledge with interdisciplinary learning experiences, including cooking, digital technology, creative arts, and entrepreneurship. Data were collected through student and parent questionnaires, as well as in-depth interviews, to explore participants' perceptions and experiences. The descriptive approach enabled the researchers to analyze both the characteristics of the activities and their outcomes in relation to student engagement and development.

Participants

The participants in this study consisted of two groups. First, five experts in activity design and botany were involved in developing and validating the extracurricular activities of the Young Botanists Club to ensure their quality, relevance, and appropriateness. In addition, a total of 100 participants were included, consisting of 50 student members of the Young Botanists Club and 50 parents of the club members. They provided data on their perceptions, experiences, and opinions through questionnaires. All participants were selected using purposive sampling to ensure that they had direct experience with the program.

Instruments

This study employed a mixed-methods approach, utilizing both qualitative and quantitative instruments to collect data. In-depth interviews were conducted with experts in activity organization and botany to support the design and validation of the Young Botanists Club activities. In addition, questionnaires were used to gather the opinions and experiences of student members of the club and their parents regarding the activities. The instruments were designed to ensure a comprehensive understanding of both the activity design and its outcomes.

In-Depth Interview

In-depth interviews are a qualitative research instrument used to collect detailed information regarding participants' opinions and experiences. In this study, they were conducted with experts in activity organization and botany to support the design and development of the Young Botanists Club activities. The interviews were semi-structured, allowing participants to freely elaborate on their responses. The questions covered aspects such as the appropriateness, relevance, and suggestions for improving the activities. The data obtained were analyzed using content analysis to enhance the effectiveness of the activity design.

Activity Plans

The activity plans were used as a research instrument to organize extracurricular activities of the Young Botanists Club. They were developed in alignment with interdisciplinary learning and experiential learning approaches. The activities were designed to be diverse, including cooking, digital technology, creative arts, and entrepreneurship, with a focus on being engaging, enjoyable, and beneficial for students. A total of 16 activity plans were implemented in this study.

Questionnaire

The questionnaire was used as a quantitative research instrument to collect data from student members of the Young Botanists Club and their parents. It was designed to assess participants' perceptions, experiences, and opinions regarding the activities. The questionnaire consisted of structured items using a Likert scale to measure key aspects such as engagement, enjoyment, and the benefits of the activities. In addition, open-ended questions were included to allow respondents to provide further comments and suggestions. It also covered the evaluation of the outcomes of the activities for students

Validity and Reliability Assessment

To ensure the validity and reliability of the research instruments, three educational experts reviewed all instruments, including the in-depth interview, activity plans, and questionnaires. The evaluation focused on content appropriateness, alignment with research objectives, and clarity of the items. Content validity was assessed using the Index of Item-Objective Congruence (IOC), and all items were found to meet the acceptable criterion (≥ 0.50). Based on expert recommendations, the instruments were revised to improve clarity and appropriateness, resulting in reliable tools for effective data collection.

Data Collection

Data were collected using multiple methods during the implementation of the Young Botanists Club extracurricular activities. First, in-depth interviews were conducted with experts in activity organization and botany to inform the design and improvement of the activity plans. The activities were then implemented with student participants. After the completion of the activities, questionnaires were administered to student members of the club and their parents to gather their opinions and experiences. The data collection process was carried out systematically to ensure the accuracy and completeness of the information.

Data Analysis

Data analysis in this study was conducted based on the type of research instruments. Data from in-depth interviews were analyzed using content analysis to identify key themes, ideas, and suggestions from experts, which were used to design and improve the activity plans. Meanwhile, data from questionnaires were analyzed using descriptive statistics, specifically percentages, to summarize students' and parents' perceptions, experiences, and opinions. In addition, responses from open-ended questions were analyzed using content analysis to identify key issues and additional suggestions.

Ethical Considerations

This study adhered to ethical principles in conducting research involving human participants. Informed consent was obtained from all participants and parents prior to data collection. Participants were informed about the purpose of the study, and their participation was voluntary. Confidentiality and anonymity were ensured by coding the data and securely storing all information. The research activities were designed to minimize any potential risks and to ensure the well-being of student participants throughout the study.

Limitations

The limitations of this study include its implementation in a single-school context and a specific sample of Young Botanists Club members, which may limit generalizability. Additionally, data collected through questionnaires may be subject to perception and response bias. The duration and frequency of the activities may also have influenced the outcomes.

Results

Design and Implementation of the Young Botanists Club Activities

The findings revealed that the extracurricular activities of the Young Botanists Club were systematically designed and effectively implemented under the concept of Blending Science, Life Skills, and Joyful Learning, in alignment with interdisciplinary and experiential learning approaches. A total of 16 activity plans were developed, and the activities were conducted once or twice a week after school.

The activities were held from 4:00 p.m. to 6:00 p.m. and were divided into two main categories: botanical learning activities (approximately 25%) and activities integrating botanical knowledge with other subject areas (approximately 75%).

All activities were organized into seven main groups: 1) Botanical learning activities, including making dried plant specimens (herbarium), listening to lectures on plant structures and plant fossils, and learning about medicinal plants in daily life; 2) Integrating botany with art, including printing plant images using the cyanotype technique and making greeting cards with dried flowers; 3) Integrating botany with computer studies, including creating botany games using Wordwall and designing greeting cards using Canva; 4) Integrating botany with cooking, including stir-fried vegetables with eggs and fruit mocktails; 5) Integrating botany with handicrafts, including painting plant pots and tray garden arrangement; 6) Herbal products, including herbal dishwashing liquid and herbal scented sachets; and 7) Learning botany through festivals, including making krathongs from natural materials during the Loy Krathong festival and creating Christmas tree-shaped vegetable salad.

The activities integrated multiple disciplines, including botanical knowledge, cooking, digital technology, creative arts, and entrepreneurship. The design emphasized variety, real-life relevance, and joyful learning experiences, allowing students to actively engage in hands-on learning.

Data from expert interviews indicated that the activity plans were appropriate, relevant, and suitable for primary school students. Experts also confirmed that the activities were well-structured and aligned with the research objectives. Their suggestions were used to refine the activities to better match students' interests and developmental levels.

In terms of implementation, the activities were carried out as planned, with flexibility to adapt to students' responses and contextual factors. The inclusion of guest speakers and hands-on experiences further enhanced the effectiveness of the program.

Overall, the design and implementation of the Young Botanists Club activities were found to be appropriate, diverse, and consistent with the concept of Blending Science, Life Skills, and Joyful Learning, promoting meaningful and holistic learning experiences for students.

Outcomes of the Activities

The findings revealed that the activities of the Young Botanists Club produced positive outcomes in terms of students' engagement, preferences, and perceived benefits. Data were collected from 100 respondents, consisting of 50 students and 50 parents.

Table 1
Students' Preferences for Activity Types (n = 100)

Activity Type	Percentage (%)
Integrating Botany with Cooking	30
Integrating Botany with Handicrafts	21
Integrating Botany with Art	17
Herbal Products	13
Integrating Botany with Computer Studies	8
Botanical Learning Activities	7
Learning Botany through Festivals	4

The results presented in Table 1 indicate that students showed a strong preference for hands-on and practical activities, particularly those integrating botany with cooking, which received

the highest percentage. This was followed by activities related to handicrafts and art, respectively.

Further findings revealed that students particularly valued cooking-related activities, citing enjoyment, opportunities for experimentation, and the tangible outcomes of their efforts. These experiences not only enhanced practical skills but also offered potential vocational relevance.

Moreover, students consistently reported that the varied nature of the sessions fostered continuous engagement, personal development, and new social connections. The presence of expert guest speakers further enriched the learning process.

Overall, the Young Botanists Club effectively bridged scientific concepts with everyday life, offering an exemplary model for holistic, interest-driven education that cultivates both knowledge and essential life skills.

Examples of Open-Ended Reflections

Examples of Students' Reflections

Student A: *I was able to use my after-school time productively. I learned about different types of plants and practiced cooking. Some of the plants were unfamiliar to me, and I had never tried them before.*

Student B: *I enjoyed cooking and learned about the benefits of various herbs.*

Student C: *The activities helped me learn more about plants, understand how they can be used, and see how they could become a career in the future.*

Examples of Parents' Reflections

Parent A: *The activities helped my child relax after a full day of studying.*

Parent B: *My child gained a variety of experiences and learned about new plants, both edible and non-edible.*

Parent C: *The activities helped my child develop life skills through hands-on practice and the integration of different subjects.*

Discussion

The findings of this study highlight the effectiveness of the Young Botanists Club in designing and implementing extracurricular activities that promote meaningful learning among primary school students. The results indicate that activities developed under the concept of Blending Science, Life Skills, and Joyful Learning can significantly enhance student engagement, learning experiences, and overall development.

In terms of activity design, the integration of botanical knowledge with interdisciplinary areas—such as cooking, art, digital technology, and entrepreneurship—created authentic and meaningful learning experiences. This finding aligns with the principles of experiential learning, which emphasize learning through direct experience and active participation (Kolb, 2015). By connecting academic content with real-life applications, students were able to construct knowledge more effectively and meaningfully. Supporting evidence from large-scale educational research also confirms that interdisciplinary and applied learning approaches enhance deeper understanding and long-term retention (Darling-Hammond et al., 2020; National Academies of Sciences, Engineering, and Medicine, 2018).

Regarding student outcomes, the results revealed that students showed a strong preference for hands-on activities, particularly those related to cooking. This can be explained by the tangible nature of such activities, which provide immediate feedback and a sense of accomplishment. These findings are consistent with research on active learning, which demonstrates that student-centered, activity-based approaches significantly improve engagement and academic performance (Freeman et al., 2014; Theobald et al., 2020).

Furthermore, the diversity of activities played a crucial role in sustaining students' engagement throughout the program. Students reported increased enjoyment, personal development, and social interaction, indicating that extracurricular activities can support not only cognitive development but also emotional and social growth. This is supported by recent research highlighting student engagement as a key factor influencing learning outcomes and overall student development (Cents-Boonstra et al., 2021; Li et al., 2023).

In addition, both students and parents perceived that the activities contributed to the development of essential life skills, including practical skills, creativity, and collaboration. These findings are consistent with global education frameworks that emphasize the importance of 21st-century skills in preparing learners for future challenges (OECD, 2019; World Economic Forum, 2020).

Overall, the findings suggest that the Young Botanists Club provides an effective model for organizing extracurricular activities that promote holistic development. By integrating scientific knowledge with practical applications and enjoyable learning experiences, the program supports students' cognitive, social, and emotional growth in a balanced and meaningful way.

Conclusion

This study concludes that the Young Botanists Club serves as an effective model for designing and implementing extracurricular activities that promote meaningful learning among primary school students. The integration of botanical knowledge with interdisciplinary and hands-on activities under the concept of Blending Science, Life Skills, and Joyful Learning successfully enhanced student engagement, learning experiences, and overall development.

The findings indicate that extracurricular activities that integrate botany with interdisciplinary learning aligned with students' interests enhance motivation and continuous engagement in learning. In particular, hands-on activities, such as cooking, help develop life skills, thinking, and problem-solving abilities, while effectively connecting knowledge to real-life contexts.

In addition, the diversity of activities and the involvement of expert speakers contribute to the quality of learning and support students' holistic development. These elements also promote personal growth, social interaction, and sustained interest among students.

Overall, the Young Botanists Club demonstrates the potential of extracurricular programs in fostering holistic education by connecting scientific knowledge with real-life experiences. The study highlights the importance of designing student-centered, interdisciplinary activities to support both academic and life skill development in primary education.

Recommendations

Based on the findings of this study, several recommendations are proposed for the development and implementation of extracurricular activities in primary education.

First, integrated extracurricular activities aligned with students' interests should be organized to enhance learning motivation and sustain engagement. Designing activities that reflect learners' preferences can encourage active participation and meaningful learning experiences.

Second, greater emphasis should be placed on hands-on activities connected to real-life contexts. Such activities not only support the development of life skills but also enhance students' thinking and problem-solving abilities through experiential learning.

Finally, collaboration with experts and the community should be promoted to improve the quality of learning. The involvement of external specialists can provide authentic knowledge, broaden students' perspectives, and enrich the overall learning experience.

Recommendations for Future Research. Future studies should explore the long-term impact of extracurricular programs on students' academic achievement, life skills, and career awareness. In addition, research could be conducted in different educational contexts or with larger sample sizes to enhance generalizability. Further studies may also investigate the integration of digital technologies or emerging tools in extracurricular activities to support innovative and adaptive learning environments.

Final Thoughts

This study highlights that designing out-of-class learning experiences that are connected to real-life contexts, aligned with students' interests, and focused on hands-on activities can make learning more meaningful and effectively support both academic knowledge and life skills. Extracurricular activities should therefore be considered an essential component of holistic education, as they foster curiosity, engagement, and lifelong learning among students.

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

In preparing this manuscript, generative AI was used solely for language refinement and grammar checking. It was not employed for data generation, analysis, or findings. All research content and conclusions were developed by the authors, who take full responsibility for the manuscript's accuracy.

References

Cents-Boonstra, M., Lichtwarck-Aschoff, A., Denissen, J. J. A., Aelterman, N., & Haerens, L. (2021). Fostering student engagement with motivating teaching: An observation study of teacher and student behaviours. *Educational Studies, 47*(2), 145–162. https://doi.org/10.1080/02671522.2020.1767184

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science, 24*(2), 97–140. https://doi.org/10.1080/10888691.2018.1537791

Fredricks, J. A., Wang, M. T., Schall Linn, J., Hofkens, T. L., & Sung, H. (2019). Using qualitative methods to develop a survey measure of math and science engagement. *Learning and Instruction, 43*, 5–15. https://doi.org/10.1016/j.learninstruc.2019.01.001

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences, 111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Kolb, A. Y., & Kolb, D. A. (2017). Experiential learning theory as a guide for experiential educators in higher education. *Journal of Experiential Education, 40*(1), 7–44. https://doi.org/10.1177/1053825916683272

Kolb, D. A. (2015). *Experiential learning: Experience as the source of learning and development* (2nd ed.). Pearson.

Li, J., Xue, E., & Li, Y. (2023). Student engagement and its influencing factors: A meta-analysis. *Frontiers in Psychology, 13*, Article 9855184. https://doi.org/10.3389/fpsyg.2022.985518

National Academies of Sciences, Engineering, and Medicine. (2018). *How people learn II: Learners, contexts, and cultures*. National Academies Press. https://doi.org/10.17226/24783

OECD. (2019). *Future of education and skills 2030*. https://www.oecd.org/education/2030-project/

OECD. (2020). *What students learn matters: Toward a 21st century curriculum*. OECD Publishing. https://doi.org/10.1787/d86d4d9a-en

Ohly, H., Gentry, S., Wigglesworth, R., Bethel, A., Lovell, R., & Garside, R. (2016). A systematic review of the health and well-being impacts of school gardening. *Journal of Public Health, 38*(2), 214–225. https://doi.org/10.1093/pubmed/fdv020

Pekrun, R., Lichtenfeld, S., Marsh, H. W., Murayama, K., & Goetz, T. (2017). Achievement emotions and academic performance: Longitudinal models of reciprocal effects. *Child Development, 88*(5), 1653–1670. https://doi.org/10.1111/cdev.12704

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology, 61*, 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Soga, M., Gaston, K. J., & Yamaura, Y. (2017). Gardening is beneficial for health: A meta-analysis. *Preventive Medicine Reports, 5*, 92–99. https://doi.org/10.1016/j.pmedr.2016.11.007

Theobald, E. J., Hill, M. J., Tran, E., Agrawal, S., Arroyo, E. N., Behling, S., Chambwe, N., Cintron, D. L., Cooper, J. D., Dunster, G., Grummer, J. A., Hennessey, K., Hsiao, J., Iranon, N., Jones II, L., Jordt, H., Keller, M., Lacey, M. E., Littlefield…Freeman, S. (2020). Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. *Proceedings of the National Academy of Sciences, 117*(12), 6476–6483. https://doi.org/10.1073/pnas.1916903117

van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2020). Determinants of 21st-century skills and 21st-century digital skills for workers: A systematic literature review. *Computers in Human Behavior, 72*, 577–588. https://doi.org/10.1016/j.chb.2017.03.010

World Economic Forum. (2020). *The future of jobs report 2020*. https://www.weforum.org/reports/the-future-of-jobs-report-2020

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