



Exploring the Theoretical Foundations of Preschool STEM Education: A Constructivist Perspective

Yi-Huang Shih

Center of Teacher Education, Minghsin University of Science and Technology, Hsinchu, Taiwan

ARTICLE INFO	ABSTRACT
Published Online: 30 June 2025	Constructivism offers a theoretical perspective that emphasizes children's active construction of knowledge, highlighting the importance of learning processes and social interaction. This aligns closely with the core principles of STEM education, such as inquiry-based learning, interdisciplinary integration, and problem-solving. Through the application of constructivist practices, preschool STEM education can not only foster young children's logical thinking and scientific literacy but also support their overall cognitive and social development. This paper aims to explore the implications of constructivism for preschool STEM education. The implications are as follows: (1) Child-centered learning is emphasized; (2) Emphasis on inquiry and problem-solving processes; (3) Emphasis on the role of social interaction and Language in Learning;(4) Focusing on learning processes rather than correct answers.
Corresponding Author: Yi-Huang Shih	
KEYWORDS: Constructivism, STEM, Young Children	

1. INTRODUCTION

Young children are perfectly adapted to learning STEM concepts. A growing body of research indicates that experiences with science, Technology, Engineering, and Mathematics (STEM) are critical in preparing young children to think critically and creatively and solve problems. These are valuable skills young children need to succeed in school, work, and life (Movahedazarhouligh, Kermani & Aldemir, 2023). Hence, the integration of STEM (Science, Technology, Engineering, and Mathematics) into early childhood education has garnered increasing attention in recent years, particularly as societies seek to cultivate problem-solving and critical thinking skills from an early age. Among the various theoretical frameworks informing STEM pedagogy, constructivism provides a compelling foundation for understanding how young

children engage with STEM concepts. Grounded in the theories of Piaget (1952) and Vygotsky (1978), constructivism emphasizes that knowledge is actively constructed by learners through direct experience, social interaction, and reflection. In preschool STEM education, this means shifting away from rote instruction toward inquiry-based learning, hands-on experimentation, and collaborative exploration. For instance, when children build structures with blocks, investigate plant growth, or explore simple machines, they are not merely learning scientific facts—they are developing cognitive schemas through active participation in meaningful contexts. These activities support what Vygotsky described as the Zone of Proximal Development (ZPD), wherein learning is scaffolded by teachers or peers to extend a child's current level of understanding (Vygotsky, 1978). Empirical studies further

validate the effectiveness of constructivist approaches in early STEM settings. Toma and Greca (2018) found that children exposed to constructivist STEM programs demonstrated not only higher engagement and motivation but also improved attitudes toward science learning. Similarly, Linder and Simpson (2017) emphasized that developmentally appropriate STEM activities grounded in play and exploration help nurture foundational skills in mathematics and scientific reasoning. Overall, constructivism offers a powerful lens through which to design and evaluate preschool STEM education. By recognizing children as active participants in their own learning processes, educators can create environments that promote curiosity, creativity, and deeper understanding of STEM-related phenomena. This paper aims to explore the implications of constructivism for preschool STEM education.

2. IMPLICATIONS OF CONSTRUCTION FOR PRESCHOOL STEM EDUCATION

Constructivist learning theory posits that knowledge is actively constructed by learners through their interactions with the environment, rather than passively received through teacher transmission (Fosnot, 2005; Piaget, 1952). This perspective offers profound implications for preschool STEM (Science, Technology, Engineering, and Mathematics) education, particularly in the following aspects:

2.1 Child-Centered Learning

Constructivism is both a learning theory and a philosophy of education that suggests learners actively build their knowledge through experiences and interactions. According to this theory, education should focus on problem-solving and critical thinking, encouraging learners to connect new information with prior knowledge. It emphasizes student-centered learning, where teachers guide rather than direct, fostering deep understanding and application (McLeod, 2025). Constructivism is an important learning theory that educators employ to help students acquire knowledge. Constructivism is based on the concept that individuals actively construct or create their own knowledge and that their learning experiences determine the nature of reality. Learners use their prior knowledge as a foundation and build upon it as they acquire

new information. The teacher acts as a guide in the learning process; therefore, constructivism supports child-centred learning (Chand, 2023).

2.2 Emphasis on Inquiry and Problem-Solving Processes

The process of finding new solutions in response to a problem is known as “issue-solving”. Critical thinking, on the other hand, is a cognitive process that entails reviewing and rearranging information in a person’s mind map. Problem-solving is a complex process that necessitates the use of critical thinking skills to provide a range of answers. Critical thinking skills were shown to impact problem-solving skills in the study, with a positive link between the two variables (Almulla, 2023). Today, the need for individuals who follow scientific and technological developments closely and who can adapt to these changes rapidly is increasing. These needs have made it necessary for countries to try various changes, reforms and current approaches required by the age in their education systems. One of these approaches is STEM education, which has frequently been encountered in the national and international literature in recent years. STEM education is an approach that emphasizes the 21st century skills, integrates science, technology, engineering, and mathematics disciplines, and covers formal and informal education at all education levels. In early childhood settings, educators can provide stimulating materials and tasks that prompt children to observe, question, hypothesize, and use tools to test their ideas, thereby cultivating logical reasoning and creative thinking (Hebebe & Usta, 2022).

2.3 The Role of Social Interaction and Language in Learning

Learning is at the core of any literacy effort as people learn not only new information and skills by participating in social activities, but also how to use and transform the information and skills to shape the social activities. Learning processes, and the related outcome of literacy (Wheaton et al, 2024). Lev Vygotsky’s sociocultural theory highlights the pivotal role of culture, social interaction, and language in shaping children’s cognitive development. Contrary to views that conceptualize learning as an isolated, individual activity (Vygotsky, 1978), Vygotsky (1978) asserted that cognitive development is

fundamentally mediated by social engagement and linguistic exchange. Through dialogue with more capable peers or adults, children are able to internalize knowledge, refine their thinking, and expand their conceptual understanding. In the context of preschool STEM education, this theoretical framework underscores the importance of educators acting as facilitators who scaffold learning experiences through purposeful language use. Teachers should encourage children to describe their observations, discuss investigative processes, articulate explanations, and collaborate with others. Such interactions not only promote scientific reasoning and inquiry but also cultivate communication skills and social competencies essential for holistic development.

2.4 Focusing on Learning Processes Rather than Correct Answers

The key idea of constructivism is that meaningful knowledge and critical thinking are actively constructed, in a cognitive, cultural, emotional, and social sense, and that individual learning is an active process, involving engagement and participation in the classroom (Zajda, 2021). Constructivism views learning as a dynamic process of exploration and revision (Fosnot & Perry, 2005). In STEM education, the learning environment should embrace errors and multiple solutions, encouraging children to try different strategies. Even if they do not arrive at the "correct answer," the thinking process itself constitutes a valuable learning experience, fostering creativity and perseverance in problem-solving.

3. CONCLUSION

Psychology—the way learning is defined, studied, and understood—underlies much of the curricular and instructional decision-making that occurs in education. Constructivism, perhaps the most current psychology of learning, is no exception. Initially based on the work of Jean Piaget and Lev Vygotsky, and then supported and extended by contemporary biologists and cognitive scientists as they studied complexity and emergence, it is having major ramifications on the goals that teachers set for the learners with whom they work, the instructional strategies teachers employ in working toward

these goals, and the methods of assessment used by school personnel to document genuine learning (Fosnot & Perry, 2005; Shih, 2024; Shih et al, 2025). The constructivist approach in education has gained significant attention for its emphasis on learner-centered instruction, active engagement, and knowledge construction. Constructivism offers a theoretical perspective that emphasizes children's active construction of knowledge, highlighting the importance of learning processes and social interaction. This aligns closely with the core principles of STEM education, such as inquiry-based learning, interdisciplinary integration, and problem-solving. Through the application of constructivist practices, preschool STEM education can not only foster young children's logical thinking and scientific literacy but also support their overall cognitive and social development (Saarsar, 2018). This paper aims to explore the implications of constructivism for preschool STEM education. The implications are as follows: (1) Child-centered learning is emphasized; (2) Emphasis on inquiry and problem-solving processes; (3) Emphasis on the role of social interaction and Language in Learning; (4) Focusing on learning processes rather than correct answers.

Through this discussion, the paper seeks to elucidate the insights offered by constructivist theory for early childhood STEM education and to contribute to the expansion of its theoretical foundations.

REFERENCES

1. Almulla, M. A. (2023). Constructivism learning theory: A paradigm for students' critical thinking, creativity, and problem solving to affect academic performance in higher education. *Cogent Education*, 10(1).
<https://doi.org/10.1080/2331186X.2023.2172929>
2. Chand, S. (2023). Constructivism in Education: Exploring the Contributions of Piaget, Vygotsky, and Bruner. *International Journal of Science and Research*, 12(7):274-278.
<https://doi.org/10.21275/SR23630021800>
3. Fosnot, C. T. (2005). *Constructivism: Theory, perspectives, and practice* (2nd ed.). Teachers College Press.

4. Fosnot, C. T., & Perry, R. S. (2005). Constructivism: A psychological theory of learning. In C. T. Fosnot (Ed.), *Constructivism: Theory, perspectives, and practice* (pp. 8–38). Teachers College Press.
5. Hebebeçi, M. T., & Usta, E. (2022). The effects of integrated STEM education practices on problem solving skills, scientific creativity, and critical thinking dispositions. *Participatory Educational Research*, 9(6), 358-379.
<https://doi.org/10.17275/per.22.143.9.6>
6. Linder, S. M., & Simpson, A. (2017). Towards an understanding of early childhood mathematics education: A systematic review of the literature focusing on practicing and prospective teachers. *Contemporary Issues in Early Childhood*, 19(3), 274-296. <https://doi.org/10.1177/1463949117719553> (Original work published 2018)
7. McLeod, S. (2025). Constructivism learning theory & philosophy of education.
<https://www.simplypsychology.org/constructivism.html>
8. Movahedazarhouli, S., Kermani, H., & Aldemir, J. (2023). STEM integrated curriculums in early childhood education: An exploration of teachers' pedagogical beliefs and practices. *International Journal of Modern Education Studies*, 7(2), 106-127.
<https://doi.org/10.51383/ijonmes.2022.266>
9. Saarsar, P. (2018). *Exploring the constructivist approach in education: Theory, practice, and implications*.
https://www.academia.edu/117138980/Exploring_the_Constructivist_Approach_in_Education_Theory_Practice_and_Implications
10. Shih, Y. H. (2024). Learning for democracy: Some inspiration from John Dewey's idea of democracy. *Frontiers in Political Science*. 6:1429685.
doi: 10.3389/fpos.2024.1429685
11. Shih, Y. H., Liu, Y. Y., Chiu, K. I., Chiang, Y. M., & Chiang, W. W. (2025). Intergenerational learning in Taiwanese preschools: Theoretical foundations and core principles for educational renewal. *Edelweiss Applied Science and Technology*, 9(4), 1920–1927.
<https://doi.org/10.55214/25768484.v9i4.6428>
12. Piaget, J. (1952). *The origins of intelligence in children*. W. W. Norton & Company. <https://doi.org/10.1037/11494-000>
13. Toma, R. B., & Greca, I. M. (2018). The effect of integrative STEM instruction on elementary students' attitudes toward science. *Eurasia Journal of Mathematics, Science & Technology Education*, 14(4), 1383–1395. <https://doi.org/10.29333/ejmste/>
14. Vygotsky, L. S. (1978). *Mind in society: Development of higher psychological processes*. Harvard University Press.
15. Wheaton, M., Ardoin, N. M., Bowers, A. W., & Kannan, A. (2024). Sociocultural learning theories for social-ecological change. *Environmental Education Research*, 30(8), 1193–1210.
<https://doi.org/10.1080/13504622.2024.2347888>
16. Zajda, J. (2021). Constructivist learning theory and creating effective learning environments. In: *Globalisation and education reforms. Globalisation, Comparative Education and Policy Research*, vol 25. Springer, Cham.
<https://doi.org/10.1007/978-3-030-71575>