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Literature Review on Integrating STEAM in Preschool: International Practices and Malaysian Implementation

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Abtract

This literature review examines the impact of STEAM (Science, Technology, Engineering, Arts, and Mathematics) education on preschool development in Malaysia, with specific emphasis on its incorporation into the National Preschool Standard Curriculum (NPSC). Although STEM education is widespread, the integration of the Arts within this framework is yet little examined in Malaysian preschools. The literature study analyzes the alignment of Vygotsky's constructivist theory, namely his Zone of Proximal Development (ZPD) and scaffolding, with the application of STEAM education. It emphasizes that practical and collaborative learning activities, guided by educators, foster creativity, critical thinking, and problem-solving abilities in young learners. The assessment examines the obstacles to STEAM integration, including inadequate resources and teacher training, and highlights programs such as GoSTEAM@Tech and EDUSIMSTEAM that tackle these concerns. The findings indicate that integrating STEAM into early childhood education can significantly enhance fundamental development, equipping children for the future and promoting innovation and creativity. It necessitates enhanced governmental funding for the training of educators and the development of curricula to comprehensively incorporate STEAM in preschools.

Keywords: STEAM Education, Preschool Development, Vygotsky's Theory, National Preschool Standard Curriculum, Early Childhood Education

Introduction

The quality of instruction and educational resources is essential in influencing children's foundational development in early childhood education. Engagement of preschoolers in experiential learning activities and scaffolding can improve psychomotor development, promote critical learning, and facilitate lifelong learning. The nation has gradually increased preschool programs since 2002. Preschools aim to develop well-rounded, critical, creative, and innovative thinkers. The National Preschool Standard Curriculum (NPSC) lists six pillars for healthy development: Communication, Spirituality, Attitudes and Values, Humanity, Self-Skills, Physical and Aesthetic Development, and Science and Technology. Preschool helps

four- to six-year-olds develop their potential in all areas, master basic skills, and establish positive attitudes in preparation for primary school. (Ministry of Education Malaysia, 2017). Based on NSPC (2017), Cross-Curricular Elements (CCE) enhance the teaching and learning process by reinforcing skills and human capital capabilities. The teaching and learning methodology grounded in the STEAM (Science, Technology, Engineering, Arts, and Mathematics) framework can augment the value of CCE as indicated in the NPSC (2017). STEAM education has not been comprehensively adopted in Malaysia, with the emphasis predominantly on the STEM framework. Consequently, this literature review seeks to investigate how the incorporation of the Arts into STEM can foster a more significant and well-rounded learning experience for Malaysian preschoolers. STEAM is an integrated initiative evolved from the prior STEM program. Alternatively, we can facilitate child development by implementing STEAM learning activities that align with Vygotsky's theories. Vygotsky's constructivist theory underscores the significance of social interactions and guided learning in fostering toddlers' CCE and STEAM education. Children learn most effectively and surmount challenges through collaboration and support within their "Zone of Proximal Development." Educators can facilitate STEAM learning to assist children in linking prior knowledge with novel experiences in science, technology, engineering, arts, and mathematics. This approach fosters analytical reasoning, innovation, and understanding of the subject matter. According to Johnston et al. (2022), STEAM can improve children's foundational development by promoting creativity and innovation through the incorporation of the Arts into STEM components. The STEAM methodology in education offers significant and culturally pertinent learning experiences. It also facilitates inquiry-based activities that promote critical thinking, problem-solving abilities, and teamwork in anticipation of future issues. This evaluation intends to examine the benefits, challenges, and strategies for executing STEAM education in preschool environments. STEAM education in preschool advances the nation's holistic child development objectives. Although STEM is emphasized in Malaysia, the Arts foster learning by promoting creativity, critical thinking, and innovation among young students. This methodology improves Cross-Curricular Elements (CCE) via experiential, inquiry-based activities that foster holistic child development and align with the National Preschool Standard Curriculum (NPSC, 2017). STEAM training is not effectively implemented in Malaysian preschools, which emphasize STEM. This gap prompts an examination of how the arts may augment STEM education for a comprehensive curriculum. This study will demonstrate how Malaysia may render STEAM education accessible, effective, and culturally relevant to achieve its educational objectives. This study assists preschool educators in enhancing their techniques through innovative approaches. It assists policymakers and curriculum developers in formulating programs that comply to NPSC and Vygotsky standards. Malaysian preschoolers will primarily enhance fundamental development, fostering creativity, problem-solving, and collaboration for future challenges.

Methodologies

Sources for this literature review were chosen from peer-reviewed publications published between 2020 and 2024 to guarantee the relevance of findings to contemporary practices in preschool education. The principal databases utilized for the literature review were Google Scholar, ERIC, and Mendeley, employing the keywords: "STEAM education in preschool," "early childhood STEAM," "benefits of STEAM," and "preschool learning theories.” The inclusion criteria emphasized research that particularly examined the incorporation of STEAM into preschool education, covering the five elements of STEAM—Science, Technology,

Engineering, Art, and Mathematics. Articles have to be empirical studies or systematic reviews published in esteemed academic publications. Six articles were initially identified. Following the evaluation of titles, abstracts, and keywords, six publications were chosen for comprehensive review. The papers were topically examined, concentrating on the advantages, obstacles, and successful implementation techniques for STEAM in early childhood education. A qualitative synthesis was performed to discern patterns among studies and to rigorously assess the contributions of each article. The integration of findings underscores significant patterns and research deficiencies, enhancing the overall comprehension of STEAM's importance in preschool education.

Literary Highlights

This literary highlight covers five relevant themes: Theoretical Framework, Benefits of STEAM Education in Preschool, Strategies for Implementing STEAM in Preschool, Innovative STEAM Program, and Implementation of STEAM in Malaysian Preschools, related to the literature assessment.

Theme 1: Theoretical Framework

For the purpose of developing well-rounded human capital, it is vital for early childhood education to emphasize the development of creative abilities, problem-solving skills, and cultural awareness. For the purpose of efficiently assisting children's cognitive and social development, Vygotsky's theoretical perspective places an emphasis on the significance of the Zone of Proximal Development (ZPD), scaffolding, learning aids, and social interaction. (Lev Vygotsky’s Theory of Child Development - Gowrie NSW, n.d.). Vygotsky's theory, which is based on Bodrova and Leong (2024), emphasizes the transforming role that social interactions, cultural instruments, and guided learning play in the development of young children. This highlights the fact that children's cognitive and social abilities develop considerably when they participate in meaningful activities within their Zone of Proximal Development (ZPD), with the support of their instructors and peers through the use of scaffolding. For the purpose of fostering self-regulation, problem-solving, and critical thinking, the method argues for the incorporation of culturally relevant tools and play-based learning. This will establish a solid foundation for learning that continues throughout one's life. According to Ofori-Attah (2021), Vygotsky’s theories, especially the Zone of Proximal Development (ZPD), have substantial effects on child development. Social interactions are crucial for cognitive development, as collaborative learning with more knowledgeable persons enables youngsters to expand upon their existing knowledge within their Zone of Proximal Development (ZPD). Scaffolding, which offers assistance throughout difficult activities, promotes cognitive development as youngsters assimilate new abilities. Vygotsky's concepts advocate for developmentally suitable pedagogical approaches aligned with children's cognitive capacities, hence enriching learning experiences. Moreover, language development, integral to Vygotsky’s theory, facilitates the regulation of ideas and behaviors, while the ZPD framework enables educators to recognize and accommodate various learning styles for enhanced results. It is possible to draw the conclusion that Vygotsky's theory can be utilized in the STEAM approach to teaching toddlers in order to foster the development of well-rounded individuals.

Theme 2: Benefits of STEAM Education in Preschool

The STEAM methodology fosters creativity, critical thinking, and problem-solving abilities in youth. The integration of the Arts with STEM creates an engaging and holistic learning environment that develops essential skills and enhances Cross-Curricular Elements (CCE). This integration promotes a comprehensive learning experience, enabling children to establish connections among several subjects, so boosting their critical and creative thinking across disciplines. It prepares young learners to tackle real-world challenges through experiential, inquiry-based activities, fostering a deep understanding of academic topics and their practical applications. The STEAM curriculum with robotic kits provides numerous advantages for children's skill development and problem-solving capabilities. It augments computational thinking (CT) by cultivating pattern recognition, logical reasoning, and debugging abilities crucial for problem-solving beyond the realm of computer science. It enhances expressive vocabulary as youngsters participate in robotic play, augmenting their language through interaction with stimulating things. The program fosters problem-solving, self-regulation, and social skills, enabling youngsters to collaborate, surmount problems, and cultivate prosocial habits. Integrating robotics into various play environments facilitates interdisciplinary learning, linking technology with language, literacy, and social connections. Ultimately, it cultivates confidence, curiosity, and favorable dispositions toward STEM disciplines, establishing a dynamic and exploratory educational atmosphere. (Sung et al., 2023). According to Chaldi and Mantzanidou (2021), their study emphasizes the advantages of STEAM activities, especially those using educational robots, for the skill development and problem-solving capabilities of young children. These exercises augment programming and computational thinking abilities, including sequencing and debugging, while also fostering critical thinking and problem-solving as students encounter problems in programming robots. Engagement with robots cultivates creativity via practical projects and promotes collaboration, enhancing teamwork and communication abilities. STEAM's multidisciplinary framework amalgamates science, technology, engineering, arts, and mathematics, enabling pupils to interrelate diverse fields of study and implement practical concepts. These activities facilitate the development of fundamental 21st-century abilities in children, such as programming, creativity, critical thinking, and teamwork, which are vital for effective problem-solving. The STEAM approach has been shown to greatly improve preschool children's skills and problem-solving abilities by combining science, technology, engineering, the arts, and mathematics via hands-on, collaborative learning experiences.

Theme 3: Strategies for Implementing STEAM in Preschool

When paired with STEAM, play-based, project-based, and hands-on learning practices boost children's creativity, problem-solving, and critical thinking. Project-based learning applies theory to practice, while play-based learning promotes exploration in a relaxed setting. Students learn by actively using technology and materials in hands-on experiences. These methods develop 21st-century talents. According to Spieler and Krnjic (2021), the "Code’n’Stitch" initiative illustrates the efficacy of project-based, experiential, and play-oriented learning in enhancing STEAM education. It integrates smartphone applications with embroidery machines to impart programming skills while allowing students to design customized textile patterns. The project promotes creativity and innovation by enabling students to apply coding in real-world contexts, transforming designs from paper into embroidered products. The practical sessions involve students with technology, fostering computational thinking and problem-solving skills. The project prioritizes playful learning,

fostering curiosity and exploration. It integrates other fields, including mathematics and the arts, so enhancing the interdisciplinary essence of STEAM and equipping students for real-world issues. As stated by Luen et al. (2024), play-based learning using STEAM toys significantly promotes toddlers' development by cultivating essential skills and encouraging holistic growth. These toys promote exploration, critical thinking, and problem-solving by involving children in tactile activities such as construction and puzzles. They amalgamate several subjects, including art and mathematics, and foster teamwork through collaborative play, so strengthening communication and social skills. STEAM toys foster creativity, stimulate new thought, and enhance technological literacy, establishing a basis for future education in technology-related disciplines. Play-based learning using STEAM toys equips preschoolers for enduring education and achievement in a progressively intricate globe. The implementation of STEAM education through play-based, project-based, and hands-on learning profoundly influences holistic development and academic advancement by cultivating creativity, critical thinking, and problem-solving abilities in children.

Theme 4: Innovative STEAM Program

Implementing the STEAM approach in preschool encounters challenges include insufficient resources, limited teacher training, and reluctance to integrate varied courses within STEAM disciplines. To overcome these challenges, it is crucial to offer professional development for instructors, guarantee access to suitable materials, and cultivate a supportive learning environment to effectively incorporate STEAM in early childhood education. The GoSTEAM@Tech program is a comprehensive initiative designed to assist educators in STEAM teaching via a holistic approach. The program comprises a five-week summer professional development initiative aimed at enhancing STEAM literacy, providing practical experiences, and promoting teamwork. Educators receive continuous support throughout the year, encompassing financial resources and instructional guidance. The program also matches educators with coaches and innovators for technical and strategic assistance. Collaboration between STEM and arts educators is advocated to develop integrated STEAM curricula, while financial support for resources and excursions enriches the educational experience. The program provides a comprehensive framework for effective STEAM implementation. (Boice et al., 2021). The "Fostering STEAM Education in Schools (EDUSIMSTEAM)" initiative established a professional development framework for educators, providing e-learning courses on STEAM integration, pedagogical strategies, and robotics. The curriculum emphasized educational techniques, technological integration, and the establishment of STEAM learning environments. The project garnered favorable evaluations for usability but, it faced hurdles such as time limitations, technological difficulties, and the necessity for a more defined course structure. The program sought to provide educators with essential skills for incorporating STEAM and robots into curriculum, hence improving their instructional methods. (Jakštė et al., 2024). Support and resources in STEAM programs, including professional development courses, instructional materials, and continuous guidance, are essential in empowering educators to effectively execute STEAM education in schools, facilitating interdisciplinary learning and cultivating creativity, critical thinking, and problem-solving abilities in students.

Theme 5: Implementation of STEAM in Malaysian Preschools

STEAM dominates primary and secondary education in Malaysia, with little emphasis on the arts. This narrow focus reduces the advantages of a STEAM approach, which encourages

holistic and multidisciplinary learning. STEAM is increasingly recognized as a tool to develop creativity and problem-solving in preschoolers, but Malaysian preschools are only beginning to use it. According to See and Ng (2022), the implementation of STEAM education in Malaysia requires an emphasis on varied educational resources and initiatives. The Ministry of Education needs to establish a STEAM program that incorporates an integration-focused curriculum in science and art, as well as a design-oriented program to enhance future employment opportunities. Educators and researchers must to collaborate in the creation of superior instructional resources, including applications, modules, and programs, that are consistent with the curriculum. Bolstering educators' self-efficacy and confidence in teaching STEAM is essential for successful implementation. Systematic training and mastery of STEAM pedagogy are essential for effective results. Additional research is required to promote the incorporation of STEAM into the curriculum and enhance educators' instructional capabilities. Integrating STEAM into educational activities can enhance students' engagement in STEM, facilitating Malaysia's objective of attaining 60% enrollment in the science stream by 2025. As stated by Awang et al. (2020), The Malaysian Ministry of Education emphasizes the significance of early STEM introduction to equip pupils for a technology-oriented future. Incorporating the Arts into STEM to create STEAM has been recognized as a method to enrich preschool education by increasing engagement and creativity. Nonetheless, obstacles such as insufficient science enrollment and a deficiency in teacher resources and comprehension impede efficient execution. The government underscores the necessity for teacher training, explicit instructions, and inquiry-based, experiential learning to cultivate curiosity and problem-solving abilities in young students. In Malaysia, there is a significant emphasis on STEM education at the primary and secondary levels, whereas STEAM, which incorporates the Arts, has not yet gained momentum, particularly in preschool education. Malaysia, in comparison to other nations, exhibits a deficiency in studies and programs prioritizing STEAM for early childhood education. Research from two publications indicates that educators require sufficient training and resources to use STEAM effectively in preschool settings. This gap highlights the need for increased research and development in the incorporation of STEAM within Malaysia's early education framework.

Conclusion

The conclusion drawn from this literature review indicates that Vygotsky’s theory, which highlights the Zone of Proximal Development (ZPD), scaffolding, and social interaction, is compatible with STEAM education for preschoolers, since it promotes creativity, problem-solving, and critical thinking. Facilitated activities and culturally appropriate tools foster comprehensive development, equipping youngsters for enduring education and upcoming problems. The STEAM methodology fosters preschoolers' creativity, critical thinking, and problem-solving abilities by integrating the arts with STEM through interactive, practical activities. Robotics play cultivates computational thinking, collaboration, and social development, while enhancing vital 21st-century abilities such as creative thinking and teamwork, so equipping children for real-world challenges. The incorporation of play-based, project-based, and experiential learning in STEAM cultivates creativity, critical thinking, and problem-solving skills. Initiatives such as "Code’n’Stitch" and STEAM toys enhance computational, social, and technological competencies through practical applications, multidisciplinary endeavors, and cooperative play, fostering comprehensive development and academic advancement. Implementing STEAM in preschools encounters obstacles such as insufficient funding and inadequate teacher training. Initiatives such as GoSTEAM@Tech

and EDUSIMSTEAM address these challenges by providing professional development, instructional resources, and continuous support. These efforts augment teachers' STEAM competencies, encourage multidisciplinary cooperation, and use technology, empowering educators to cultivate creativity, critical thinking, and problem-solving in young learners. Thorough assistance guarantees efficient STEAM education, equipping pupils for future challenges. Malaysian preschools are deficient in STEAM, whereas primary and secondary institutions prioritize STEM. This impedes the creativity and problem-solving abilities of young learners. The government must prioritize the training of educators, the development of resources, and the design of curricula for the integration of STEAM. Research indicates a greater necessity for STEAM courses and activities in early childhood education to foster curiosity and achieve Malaysia's 2025 science stream enrollment objective. This research is beneficial in promoting holistic development by incorporating STEAM education to improve critical thinking, creativity, and problem-solving skills vital for lifelong learning. Based in Vygotsky's Constructivist Theory, it fosters social interaction and guided learning, facilitating successful knowledge acquisition. The utilization of culturally relevant teaching tools, like the embroidery kit, improves engagement and inclusion, catering to varied preschool learning requirements. STEAM integrates scientific inquiry, technical proficiency, and artistic creativity to produce comprehensive educational results, equipping children for future challenges and nurturing a lasting passion for learning.

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