

**INTERNATIONAL JOURNAL OF  
EDUCATION, PSYCHOLOGY  
AND COUNSELLING  
(IJEPC)**  
[www.ijepc.com](http://www.ijepc.com)



## **STEM ACTIVITIES WITH PRESCHOOLERS: PRE-SERVICE EARLY CHILDHOOD TEACHERS' EXPERIENCES**

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### **Article Info:**

#### **Article history:**

Received date: 30.07.2025

Revised date: 20.08.2025

Accepted date: 29.09.2025

Published date: 27.10.2025

#### **To cite this document:**

Khalsa, K. B. (2025). STEM Activities with Preschoolers: Pre-Service Early Childhood Teachers' Experiences, Challenges and AI Integration. *International Journal of Education, Psychology and Counseling, 10* (60), 737-747.

**DOI:** 10.35631/IJEPC.1060053

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### **Abstract:**

This study aims to explore the experiences of pre-service early childhood education (ECE) teachers in conducting STEM activities with preschoolers. This study employed a combination of quantitative and qualitative approaches to collect the data. Questionnaires were distributed to 19 pre-service early childhood education (ECE) teachers who were involved in STEM activities with preschoolers. The findings showed that 68.4% of them had no idea what STEM was, even during their secondary education, and 73.3% of them were quite confused about STEM before they took the Science and Technology course. SPSS indicated a high mean value of 4.32, suggesting that pre-service (ECE) teachers felt fulfilled and happy conducting STEM activities with preschoolers. A mean value of 4.11 indicated an increased confidence level among the teachers in carrying out STEM activities. Qualitatively, semi-structured interviews were conducted to gather information and understand the teachers' experiences during STEM activities. Pre-service (ECE) teachers reported that STEM activities improve their self-confidence in executing them, they are practical and engaging for preschoolers, and concurrently enhance problem-solving, through the combination of science, technology, mathematics and engineering elements. In conclusion, STEM activities are fun, integrated, and uncomplicated, while promoting holistic development in young children. The experience gained positively enhanced the teachers' knowledge of STEM and increased hands-on, yet exciting opportunities for the preschoolers.

### **Keywords:**

STEM, Early Childhood Education, Pre-Service Teachers, Science in Early Childhood, Technology, Engineering, Mathematics

## Introduction

STEM is a combination of Science, Technology, Engineering, and Mathematics, which provides opportunities to employ a merged and diverse approach from different fields (Hafni, Herman, Nurlaelah, & Mustikasari, 2020). STEM encourages hands-on projects and tasks through exploration, promoting solutions to real-world problems that foster critical thinking among learners (Saifulbahri Abdul Rahman, Abdul Halim Busari, Mohammad Nur Azhar Mazlan, & Adawati Suhaili, 2025). The Malaysia Education Blueprint (2013-2025) signifies the importance of STEM in Shift 1, which aims to enhance the learning standards of Mathematics and Science, and improve the quality of education in STEM, focusing on Science, Technology, Engineering, and Mathematics (Malaysia Education Blueprint, 2013-2025: Preschool to post-secondary education, 2013). Concurrently, the ministry highlighted in the same blueprint that the teachers must be furnished with continuous professional growth through training to enhance teaching methods aligned with 21st-century learning to encourage creative, technology-based and vigorous teaching and effective student-centred learning.

It was affirmed by Karademir and Yıldırım (2021) that significant endeavours were taken to incorporate STEM into the entire learning platforms, starting from preschoolers to university. However, it was interpreted that the preschool teachers are less informed and less experienced in STEM compared to other levels of education. A similar conclusion was elaborated by Hoon, Narayanan, Sharipah Ruzaina Syed Aris and Norezan Ibrahim (2022), that the Malaysian government is making efforts to increase the standards of teachers comprising the pre-service teachers. Considering these pre-service teachers as the forthcoming young educators with the equipment of 21st-century skills, they play a key role in ensuring proper STEM lessons and activities are designed for the students.

According to a previous study by Kurup, Li, Powell, and Brown (2019), pre-service teachers demonstrated imperfection in associating the elements of science, technology, engineering, and mathematics, as well as in connecting STEM teaching and learning strategies with real-life scenarios. The study's results revealed that the courses provided at the university are insufficient to equip pre-service teachers to teach STEM in schools. Further elaborated by the researchers, these pre-service teachers would like to incorporate STEM in teaching and learning activities, but they are uncertain about it and suggested that training should be provided to them. This indicates that pre-service teachers need more exposure to STEM experiences to accommodate the 21st-century learning methods. Therefore, to close this gap, it is necessary first to perceive the pre-service teachers' experiences in conducting the STEM activities with preschoolers.

This study aims to ascertain the pre-service early childhood education (ECE) teachers' experience gained from STEM activities with preschoolers.

## Literature Review

### ***Importance of STEM in Early Childhood Education (ECE)***

Child development occurs during a crucial period in early childhood, when holistic growth can be observed in young children, encompassing cognitive, social, and emotional development. STEM education in early childhood is vital, as it is a method to encourage holistic development among preschoolers by engaging them in active learning through group communication (Çiftçi, Topçu, & Foulk, 2020). This is supported by Aldemir and Kermani (2017), who described

preschoolers as individuals who are very much ready to examine, investigate and enjoy inquiring or asking questions. Further elaborated by the researchers, in preschool, children learn the foundation of life and earth science through weather observation, exploring water and mud, and caring for the pet animals in the class. In addition, block and constructive play introduce the concept of engineering, and an introduction to Early Mathematics establishes the concepts of mathematics to children (Aldemir & Kermani, 2017). The basic mathematics skills introduced during ECE help children apply them in daily life, improving their thinking and problem-solving skills (Hassan, Abdullah, Ismail, Suhud, & Hamzah, 2018). Hence, STEM should be given a priority and promoted in the ECE industry so that young children can gain the numerous benefits it offers.

### ***Related Theories to STEM Education***

In a study by Ghazali, Mohamad Ashari, Hardman, Omar, and Handayani (2023), two theories related to STEM education in preschools were identified. It was shared by Ghazali et al. (2023) that the first theory, Dewey's Education Theory, emphasised learning with pleasure, as it provides encouragement and enables children to sustain themselves in a continuous learning environment. It benefits the children and teachers through a quality learning experience and environment, beginning from the early stages of life. Secondly, Vygotsky's Sociocultural Theory emphasises that the educator's task is to assist children in acquiring profound knowledge by expanding it to understand related topics and activities (Ghazali et al., 2023). The term scaffolding, by Vygotsky, helps children to master learning at their own pace. As children have different learning styles and abilities and skills, the assistance from the environment is vital and encouraging them to believe in their understanding will make the learning process efficient (Ghazali et al., 2023). In this research, Dewey's Education Theory and Vygotsky's Sociocultural Theory are two theories highlighted related to STEM, which will bring enjoyment, excitement in acquiring STEM education and learning through support.

### ***Pre-Service ECE Teachers' Experience with STEM Activities***

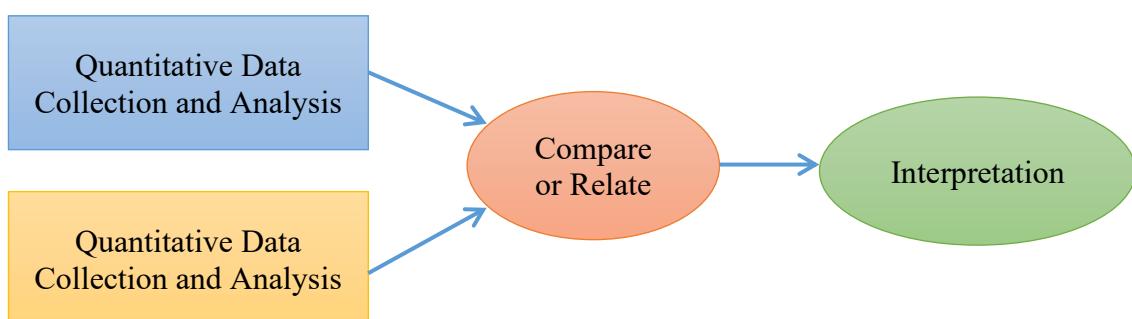
According to Çiftçi et.al (2020), through the study in Turkey, the pre-service (ECE) teachers shared that STEM-based activities or education can be conducted through project-based, play-based and interdisciplinary approaches. These approaches can be implemented by using simple materials to encourage observation, exploration and communication while the preschoolers play or perform the projects.

Based on the research by Çiftçi et.al (2020), pre-service (ECE) teachers positively expressed their perceptions on STEM education. They mentioned that STEM education grants cognitive and social development while building a positive attitude towards STEM, along with the knowledge of 21st-century skills.

Research on STEM education by Lange, Robertson, Tian, Nivens, and Price (2022), which consists of 52 pre-service ECE teachers, observed that the teachers' confidence level was expanded to teach science with STEM integration as they learned to plan, integrate and teach during the STEM project. Besides that, the pre-service teachers shared that hands-on activities as one of the vital key criteria that must be included to improve the adaptation of STEM education by the young children. Additionally, the pre-service teachers pointed out that STEM education becomes engaging for the children when there is the incorporation of elements such as science and mathematics, which contributed to deep understanding and active learning (Lange et al., 2022).

## Methodology

This study employed a mixed methods approach to data collection and analysis. Mixed methods design proposes a thorough interpretation of the research (Sharma, Bidari, Bidari, Neupane, & Sapkota, 2023). In this research, the convergent parallel design (Figure 1), which is a mixed methods design, is employed. This design allows the researcher to collect both quantitative and qualitative data, analyse, compare, or relate them to understand if the results support or contradict each other (Creswell & Creswell, 2018).



**Figure 1. Convergent Parallel Design.** Adapted from *Exploring the Mixed Methods Research Design: Types, Purposes, Strengths, Challenges, and Criticisms*, by Sharma et al., 2023, *Global Academic Journal of Linguistics and Literature*, 5(1), p. 7. Copyright 2023 by Global Academic Journal's Research Consortium (GAJRC).

A total of 19 pre-service ECE teachers who took the Science and Technology (ST) subject in their second year of Bachelor of ECE in a private institution voluntarily participated in this research. The purposive sampling method was adopted in this research as the pre-service teachers were needed as samples from the ST subject. These pre-service ECE teachers planned STEM lesson plans and executed a science fair with preschoolers in one of the Kindergartens in Petaling Jaya.

The data was collected through survey questions (5 Likert scale), and semi-structured interviews. The STEM questionnaires and semi-structured interview questions were adapted from *STEM for Future*, 2022. They were sent to 2 ECE experts to be verified, edited and sent to the participants. The data was analysed using SPSS (Statistical Package for the Social Sciences) and thematic analysis based on Braun and Clarke's approach (Byrne, 2021).

Table 1 portrays the interpretation of mean score indicators. The table shows scores between 1.00 and 1.89 as a very low mean score level, scores between 1.90 and 2.69 as a low mean score level, scores between 2.70 and 3.49 as a moderate mean score level, scores between 3.50 and 4.29 as a high mean score level and scores between 4.30 and 5.00 as a very high mean score level.

**Table 1**  
**Mean Score Indicators**

Mean Score	Interpretation
4.30 – 5.00	Very High
3.50 – 4.29	High
2.79 – 3.49	Moderate
1.90 – 2.69	Low
1.00 – 1.89	Very Low

*Note.* Adapted from *The Level of Integration among Students at Secondary School: A Study in Limbang, Sarawak*, by Zaki & Ahmad, 2017, p. 3285. Copyright 2006 by Education Policy Planning and Research Division, MOE (BPPDP) and Kuala Lumpur Education Development Master Plan (PIPP) in The International Journal of Social Sciences and Humanities Invention.

### Findings

To answer the research question, the discussion focuses on quantitative, qualitative, and the integration of both data types.

#### ***How Do the STEM Activities with Preschoolers Relate To the Pre-Service ECE Teachers' Experience?***

Before the introduction of STEM through the ST subject, 68.45% of the preservice ECE teachers claimed that they had no knowledge of STEM, even during their secondary education. 73.7% admitted that they were confused about STEM before taking the ST subject.

#### ***Quantitative results: Questionnaires***

On the day of the science fair, the pre-service ECE teachers conducted STEM activities with preschoolers in a kindergarten. Pictures of the STEM activities are shown in Figures 2 to 5 according to the science concepts such as life science, health science, earth & environment science and physical science. The preschoolers visited all four STEM activity stations planned and prepared for them, and the pre-service ECE teachers repeated their STEM activities 6 times to cater to the 6 preschoolers' groups.



**Figures 2. Life Science. Preschoolers Listen to the Instructions and Use the Cow Replica.**



**Figures 3. Health Science. Preschoolers Listen to A Heartbeat Using a Stethoscope and Build A DIY Heart.**



**Figures 4. Earth Science. Preschoolers Build the Mountain and Do the Volcano Experiment.**



**Figures 5. Physical Science. Preschoolers Are Introduced to the Balance Scale, And They Do the Sink and Float Experiment**

Before the STEM activities were carried out with preschoolers, a mean score of 2.32 demonstrates that the pre-service teachers' confidence in carrying out the STEM activities was at a low level, in Table 2. On the other hand, Table 3 shows a mean value of 4.11, indicating an increased confidence level among the teachers in carrying out STEM activities. This indicates that the teachers have magnificent experience conducting the STEM activities. In addition to that, the pre-service ECE teachers were extremely satisfied with the STEM activities they planned and implemented with the preschoolers. The mean value, 4.32, suggests a very high satisfaction level among the teachers.

**Table 2**  
**Descriptive Statistics for Confidence Level Before Carrying Out STEM Activities with Preschoolers**

	N	Minimum	Maximum	Mean	Std. Deviation
No confidence in carrying out STEM activities	19	1	4	2.32	1.003
Valid N (listwise)	19				

*Note.* N=19 (n=19 pre-service ECE teachers). Low mean value 2.32, teachers have no confidence.

**Table 3**  
**Descriptive Statistics for Confidence and Satisfaction Level after Carrying out STEM Activities with Preschoolers**

	N	Minimum	Maximum	Mean	Std. Deviation
Confidence level	19	3	5	4.11	.459
Satisfaction level	19	3	5	4.32	.582
Valid N (listwise)	19				

*Note.* N=19 (n=19 pre-service ECE teachers). High confidence and satisfaction level, 4.11 and 4.32, respectively.

Preschoolers were observed by the pre-service ECE teachers as individuals who like to invent things. At the same time, they attempted to solve problems by experimenting, participating in STEM activities planned for them, and answering questions. Table 4 shows a mean value of

4.42, indicating a very high aptitude of the preschoolers towards inventing new things, which suggests a close relationship to problem-solving.

**Table 4**  
**Mean Score for Preschoolers' Enjoyment in Inventing Things During the STEM Activities**

	N	Minimum	Maximum	Mean	Std. Deviation
Children like to invent things and solve problems	19	2	5	4.42	.769
Valid N (listwise)	19				

*Note.* N=19 (n=19 pre-service ECE teachers). Children like to create things, on average, 4.42.

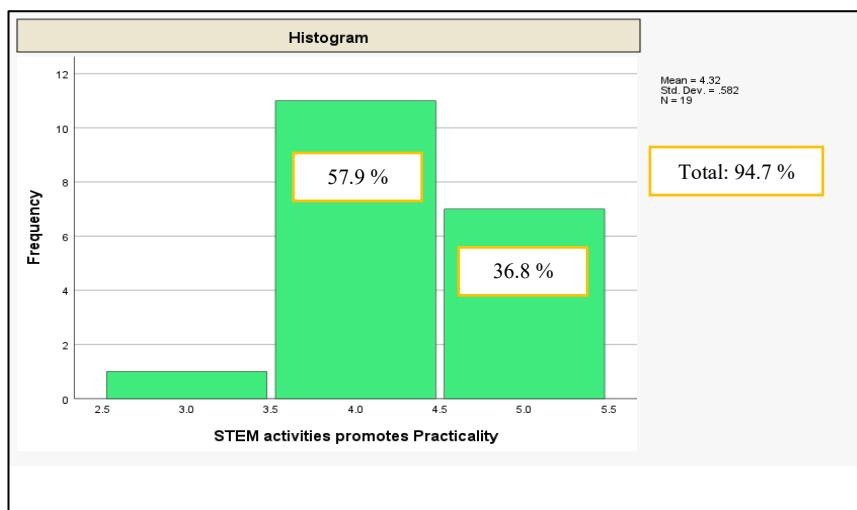
It was interesting to note that the mean value in Table 5 shows a very high score of 4.58, indicating the excitement and fun moments the pre-service ECE teacher had while carrying out STEM activities for preschoolers. This suggests that pre-service teachers enjoy executing STEM activities and should be able to implement them with preschoolers in the future.

**Table 5**  
**Descriptive Statistics for Excitement & Fun with STEM Activities**

	N	Minimum	Maximum	Mean	Std. Deviation
I have fun during the STEM activities	19	3	5	4.58	.607
Valid N (listwise)	19				

*Note.* N=19 (n=19 pre-service ECE teachers). Fun STEM activities with a mean of 4.58.

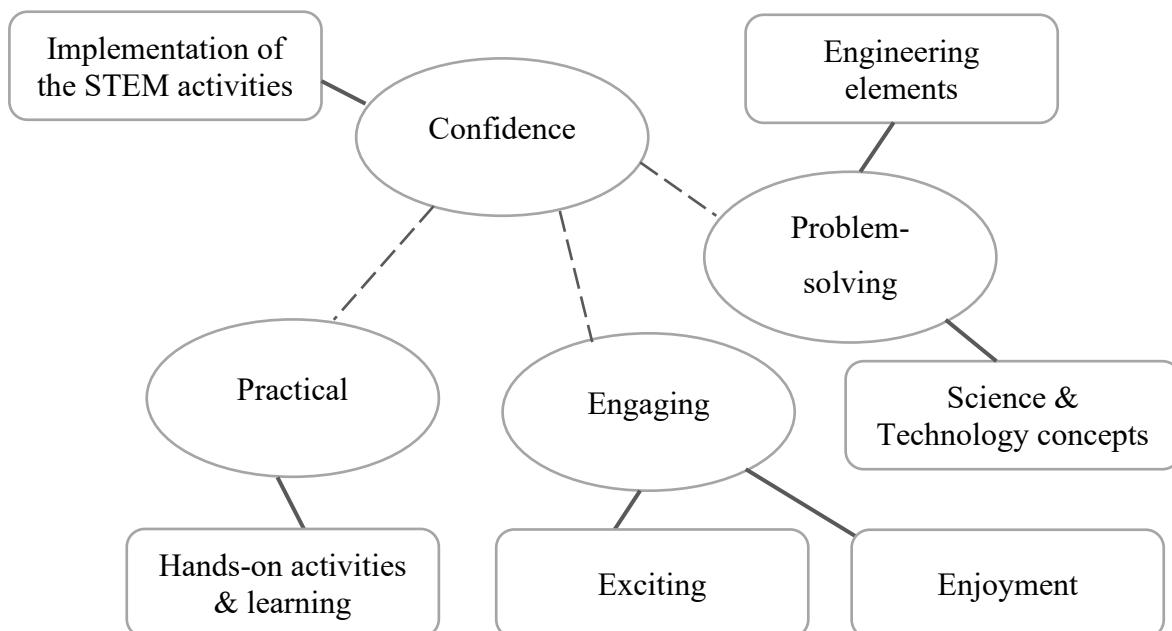
Figure 10 shows that the STEM activities notably promote the hands-on experience for both the preschoolers and the teachers. The mean value shows 4.32, a very high-level mean score, with 94.7 % suggesting that the teachers agree that STEM activities foster the attainment of practicality.



**Figure 10. STEM Activities Promote Practicality Versus Frequency.**

#### ***Qualitative Results: Semi-Structured Interview***

A total of 4 themes were derived from the semi-structured interview. Figure 11 shows confidence, problem-solving, practical and engaging as the identified themes under the main theme of experience. The results display the teacher's feedback for each theme, and the pre-service teachers are identified as PT1, which means pre-service teacher 1 and subsequently.



**Figure 11. Thematic Map Demonstrating Four Themes of Experiences.**

### ***Confidence***

The pre-service ECE teachers' feedback about their confidence during the STEM activities.

“I understood more about STEM elements, offering me *confidence* to implement this in classroom activities, for example, children can measure the ‘milk’ they collected from the cow replica and say out the amount by measuring using the cups” (PT1).

“We introduced the human heart to children through an experiment *confidently*, while the children counted 1 to 20 when pumping the heart model” (PT2).

“The volcano eruption experiment was fun and boosted our *confidence level* to do it with young children, while they were calculating the scoops of baking soda” (PT3).

### ***Practical***

Most of the pre-service ECE teachers shared that the STEM activities they executed were hands-on, interactive and participatory.

“It was interactive and *hands-on activities* captured children’s attention and enthusiasm” (PT3).

“Importance of *hands-on learning*, adaptability and flexibility” (PT10).

“Children are more interested in *hands-on activity* compared to normal teaching” (PT14).

### ***Problem-solving***

Problem-solving skills were noted by the teachers as well.

“Children assemble the body parts of the cow, and it enhances their *problem-solving skills* and impacts the engineering element of STEM” (PT1).

“We let the children build the heart model, and this encourages their thinking skills and able to *solve problems*” (PT6).

“Through the STEM activities, children can learn complex science and technology concepts relevant to daily life and learn to *solve problems*” (PT18).

### ***Engaging***

The preschoolers were engaged with the STEM activities.

“I saw children were very *excited* during my group’s STEM activities” (PT3).

“Everyone *enjoyed* it and it was an activity that suited most children” (PT16).

“We can see children do it very well, children show *excitement* and interest in the material provided” (P14).

### **Integration Of the Results**

Both strands consistently showed that one of the outstanding experiences felt by the teachers was a greater level of confidence. While the questionnaires indicated a high level of confidence achieved by the pre-service ECE teachers, the semi-structured interview data revealed that STEM activities boosted their confidence level as well. Both the data suggest that the STEM activities were exciting, fun and engaging, although some felt that they were time-consuming.

### **Discussion**

The findings from the research question in this research indicate that the pre-service ECE teachers had an increased confidence level through the practical STEM activities with preschoolers. In the beginning, they did not have the confidence to carry them out with preschoolers. However, the science and technology subject, which required the implementation of the STEM activities, eventually boosted the positivity. This result is supported by the previous study by Lange et al. (2022), which revealed the expansion of confidence level in the teachers. In addition to that, it also demonstrated the way preschoolers were engaged in the STEM activities.

### **Implications**

In the course of executing STEM activities with the preschools, the pre-service ECE teachers were able to plan STEM lessons, align them with the KSPK learning standards, and ensure the integration of all the STEM elements. The STEM activities with preschoolers have impacted the ideas and perceptions of these teachers towards STEM curriculum. The execution and implementation were engaging, hands-on, and left a positive impression of STEM education.

### **Recommendations and Conclusion**

Therefore, future research should explore ways to promote STEM activities at preschools among young children. This is because STEM education fosters holistic development among children and supports active learning (Çiftçi, 2020). As promoted by Dewey's and Vygotsky's theories, learning should be exciting and joyful, which enhances the individualised and impactful learning among preschoolers (Ghazali et al., 2023).

### **Acknowledgement**

I would like to extend sincere gratitude to HELP University for the support in terms of resources and encouragement to publish research papers. **Publication of this work was supported by HELP University, Malaysia [Publication Charge Support Grant 25-09-011]**

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