TEACHER-READINESS IN STEM TEACHING IN SELECTED PRESCHOOLS

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Abstract

This study examined teacher-readiness in teaching science and technology (STEM) subjects among preschool teachers. Readiness aspects investigated were topical content knowledge, instructional strategies, resources available to teachers, school infrastructure, training, and chances for professional growth. The study used a mixed-methods approach in which data were collected through survey and interviews on a sample involving 51 teachers from 29 preschools in the district of Hulu Langat, Selangor, Malaysia. Based on data analysis, results indicated that teachers lack the ICT skills necessary for teaching STEM subjects, and they were also concerned about how technology might affect STEM education. Programmes for internal training should be the vital means of professional growth because the lack of specialised STEM educators seemed to be a major factor in the STEM education gap since it could limit teachers' access to professional development opportunities that would improve their subject-matter expertise and abilities. Analysing technology aversion could reveal obstacles to enhancing ICT competence. To fill in subject knowledge gaps, especially in engineering and technology, the study suggests integrating soft

skills into STEM teaching approaches. In order to facilitate teachers' professional development, school training departments ought to prioritise networking and self-directed learning. Flexible work arrangements should be considered to enhance work-life balance and facilitate teachers' continuous professional development (CPD) initiatives. Understanding the differences in experience levels among teachers from different educational backgrounds could accommodate the needs of both beginner and experienced teachers.

Keywords: Continuing professional development, science teaching, ICT skills, soft skill

Introduction

The main aim of this study was to explore effective methods for preparing a group of certified preschool teachers for careers in STEM fields. The research highlighted the importance of recruiting, developing, retaining, and advancing high-quality preschool educators to adequately prepare children for STEM learning. Effective teachers play a crucial role in influencing students' academic success, serving as role models, and shaping educational practices, as stated by Mincu (2015). The benefits of a teacher preparation program include age-appropriate use of technology, personalized learning strategies, opportunities for professional growth, and collaboration. Further investigation is needed to fully understand how technology impacts academic performance. Specifically, this study examined preschool teachers' readiness for STEM education by addressing three research questions:

1. Their current understanding and skills in the STEM concepts,
2. Challenges faced in integrating ICT into STEM education, and
3. Available professional development opportunities.

The research aimed to identify areas of teacher unpreparedness, understand barriers to integrating ICT, and assess the effectiveness and accessibility of professional development opportunities. The findings could potentially enhance preschool STEM education through targeted interventions, policy adjustments, and improved practices.

STEM education has been prioritized by the Malaysian government across all educational levels, including preschool, due to its connection to STEM expertise, innovation, and economic growth. STEM education encourages students to actively construct their own knowledge, reducing the

reliance on teachers for knowledge dissemination. Preschool teachers, particularly those in rural or low-income areas, may lack exposure to STEM subjects and feel uncertain about their knowledge. This study focused on preschool teachers' readiness to implement STEM education techniques in Hulu Langat, Selangor, Malaysia. Previous research by Sanders (2008) and Roehrig, Moore, Wang, and Park (2012) has emphasized the importance of strategies such as active learning, experiential learning, and student-centred approaches to enhance STEM teaching.

Literature Review

This section critically reviewed recent studies on preschool teachers' readiness for STEM education strategies at both global and local levels. It examined essential components necessary to address STEM proficiency and ICT skills, emphasizing the need to dispel misconceptions about technology use and promote collaborative professional development opportunities to enhance teachers' STEM proficiency.

Globally, research by Nadelson et al. (2009) has shown that many preschool teachers feel unprepared to teach STEM subjects due to limited formal education and training. While most states require basic training, many teachers lack confidence and expertise. Studies from Idaho, Turkey, and South Africa have revealed that preschool teachers perceive STEM concepts in terms of skills, career opportunities, and teaching methods. In South Africa, inadequate STEM teaching is attributed to teachers' struggles with ICT integration. Access to an ICT literacy program could lay the foundation for ongoing professional development. However, low requirements for STEM study in teacher certification programs may leave teachers feeling underprepared. According to Jarrett (1999), teacher

education programs significantly influence confidence levels, with additional coursework and professional development in STEM topics boosting teachers' confidence in STEM instruction.

Regionally, the rapid expansion of STEM education in Asia has increased demand for qualified preschool STEM educators. However, teachers often struggle to grasp the interconnectedness of STEM subjects, making teaching in STEM areas challenging. A study in Thailand by Pimthong and Williams (2018) found that preschool teachers prioritize real-world relevance in STEM education but struggle to define it. The study suggests that teachers should be well-versed in STEM education and integration concepts, rather than relying on siloed approaches. In Bandung, Indonesia, Shidiq and Nasrudin (2021) found that preschool teachers' limited understanding of various ICT technologies hinders their readiness to adopt STEM subjects. Despite the development of robust STEM integration teaching resources, teachers face challenges in implementing their plans consistently. Continuous professional development is essential to bridge the gap between planning and execution. Teachers are eager to engage in STEM-related professional development opportunities, often through face-to-face interactions.

In Malaysia, schools prioritize STEM education to support the country's science-based economy. However, according to Ramli et al. (2017), teachers are not fully prepared to implement STEM education due to a lack of extracurricular materials, reluctance to teach other subjects, and limited access to technology resources. Professional development is crucial for enhancing teachers' confidence in STEM instruction and providing them with up-to-date knowledge and instructional strategies. Regular assessments

of teacher preparedness are essential for effectively modernizing the education system. Preschool educators in Malaysia are exploring effective strategies for teaching STEM subjects, but further research is needed to understand the impact of technology on instructional outcomes and to overcome existing obstacles. This could raise awareness, inform policy-making, and promote a culture of continuous improvement.

Theoretical Framework of the Study

This study employed two theories to explain and evaluate preschool teachers' readiness for STEM education. Firstly, the pedagogical theory provided a framework for examining effective educational methods, focusing on six factors for fostering creativity: teaching techniques, physical context, timing and planning, assignments, evaluations, and feedback as proposed by Dineen and Niu (2008). This theory offered specific strategies for promoting learning, such as direct instruction, inquiry-based learning, collaborative learning, problem-solving instruction, and blended learning, while also emphasizing the importance of creating a supportive educational environment and utilizing educational technology. Secondly, the Pedagogical Content Knowledge (PCK) theory underscored the intersection of subject matter knowledge and pedagogical expertise in teaching. This theory required teachers to have a deep understanding of content and effective teaching methods. High PCK teachers could simplify complex concepts, develop instructional materials, identify appropriate learning activities, and adjust methods to accommodate diverse student experiences and learning styles, as outlined by Shulman (1986). This approach aimed to effectively engage students in learning processes

The Technological Content Knowledge (TPACK) framework by Koehler and Mishra (2009), suggests that teachers need to integrate three essential areas of knowledge for effective STEM education: Content Knowledge (depth of knowledge and application of theory), Pedagogical Knowledge (knowledge of instructional strategies, assessment procedures, classroom management), and Technological Knowledge (understanding the limitations and potential of technological tools).

Conceptual framework of the Study

Figure 1 illustrates the theoretical and conceptual frameworks TPACK and TCK, which are derived from TPACK and aimed at preparing preschool teachers for STEM education. TPACK focuses on the preschool context, while TCK emphasizes teachers' understanding of technology and its application in STEM. PCK assesses teachers' readiness to integrate pedagogical content knowledge into STEM education. The study seeks to examine how teachers' PCK influences their preparedness for successful STEM teaching. TPK emphasizes teachers' awareness of fundamental scientific concepts, technological principles, mathematical fundamentals, and engineering design processes. These findings will assist school administrators in devising strategies to enhance TPK development and support preschool teachers in STEM education.

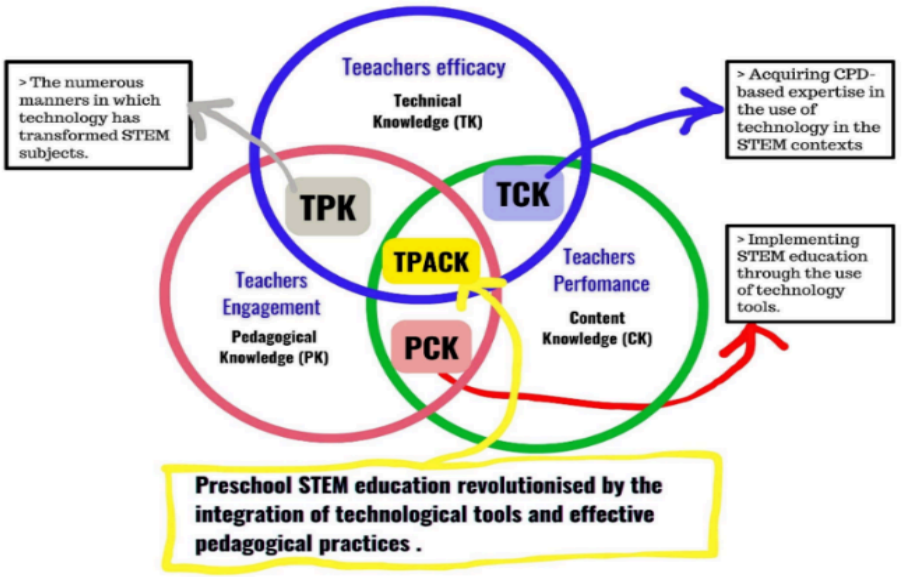


Figure 1

Conceptual framework in preschool teachers' readiness in STEM education.

According to constructivist theory, teachers must acquire STEM concepts and develop a thorough understanding through a constructivist approach. This approach fosters student learning by creating a challenging environment, responding to students' mental activities, and modelling and questioning their comprehension, as noted by Green and Gredler (2002). Preschool teachers can enhance their skills, confidence, and pedagogical strategies through STEM activities, problem-solving tasks, and inquiry-based learning.

Research Methodology

The research employed both quantitative and qualitative techniques, combining these methods to understand school reform implementation and the intersection of rural sociology and regional economics. Triangulation

was utilized to validate findings and enhance credibility by comparing results from various data sources and minimizing the influence of any single technique. Grounded theory, as described by Charmaz (1996), was used as a research methodology that systematically analysed evidence to comprehend individuals' experiences and understandings. It established connections between different ideas, forming a foundational framework that influenced behaviour and social-psychological aspects. This study utilized grounded theory to investigate challenges in teachers' confidence in teaching STEM subjects, their skills judgments, and learning from others. The iterative process of comparison, coding, and categorization enabled a comprehensive examination of qualitative data. The insights gained can inform teacher preparation, professional growth, and educational material development, thus facilitating advancements in early childhood STEM instruction.

Population and Sample

The study investigated STEM teaching strategies in rural preschools in Hulu Langat, Selangor, Malaysia. The research population comprised preschool teachers involved in STEM education. Previous research had identified teachers' skills as the primary barrier for private preschool teachers in Hulu Langat, impacting their lesson planning. Purposive sampling was utilized to select rural participants with expertise in STEM education. This sampling method allowed for a unique and cost-effective approach to data collection, enhancing efficiency and producing high-impact results. The study aimed to provide comprehensive knowledge and understanding of preschool teachers' preparedness for STEM education.

Data Collection Method

The study explored preschool teachers' readiness in STEM practices using both quantitative and qualitative methodologies. Data were collected through surveys and interviews, with Google Forms chosen for confidentiality and cost-effectiveness. Phone interviews expedited feedback. Open-ended online survey questionnaires, as depicted in Figure 2, were employed to understand STEM components, while closed-ended Likert scale surveys were used to investigate teachers' expertise in pedagogy and ICT integration. Semi-structured interviews addressed concerns about Continuing Professional Development (CPD) and the growing demand for skilled STEM teachers in Hulu Langat.

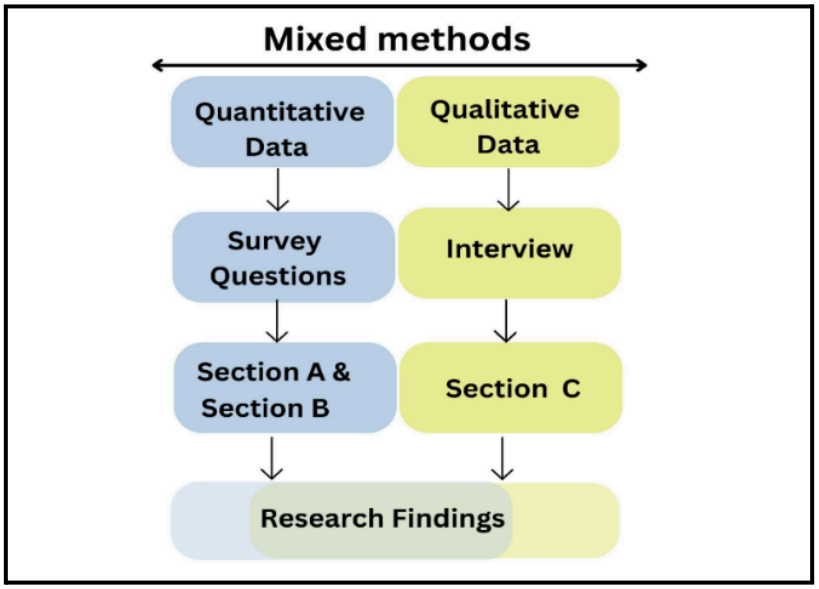


Figure 2

Types of instrumentation and data used

Semi-Structured Interview (Qualitative Data)

The research employed grounded theory and case study analysis to examine the experiences of preschool teachers. Conducted in English, the interviews were conducted with permissions granted by the school administration. The interviews focused on professional development and teaching techniques. Data analysis utilized descriptive coding methods proposed by Taylor and Gibbs (2010), and participants provided contact information for further communication. The study ensured the confidentiality of individual personal information. Subsequently, the data underwent multiple readings to categorize and analyse the interview responses. Descriptive codes provided flexibility in data interpretation, closely tied to responses. Thematic analysis and quantitative analysis were employed to elucidate qualitative data results, while confidentiality was maintained during interviews. Thematic analysis expounded upon qualitative results, while quantitative analysis scrutinized Likert-scale responses.

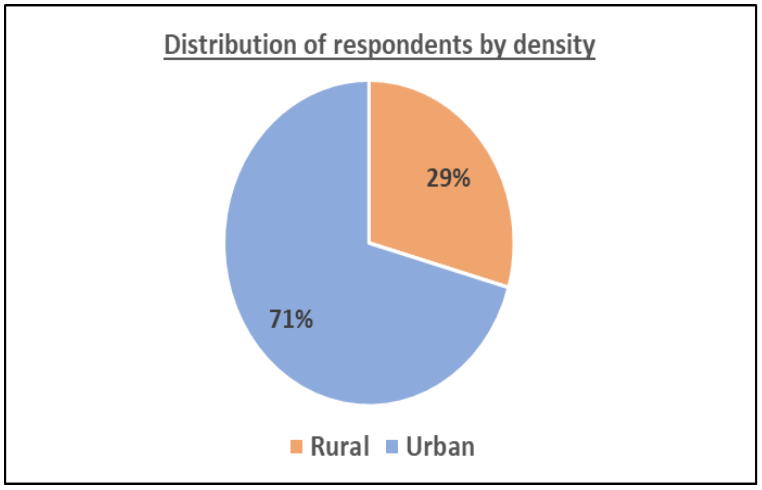
Reliability and Validity

This mixed-method study focused on reliability and validity in research. Reliability pertained to the consistency and stability of measurements utilized, while validity concerned the accuracy and meaningfulness of observations. The Likert-type scales employed in the study significantly impacted the credibility and comprehensibility of the collected data. The survey instrument's reliability in assessing teachers' preparedness in STEM concepts was found to be excellent, with a Cronbach's Alpha coefficient of 0.964. However, the reliability of section B, which concentrated on

integrating ICT into teaching STEM, demonstrated moderate internal consistency. The study also underscored the importance of specific instruments such as mechanical recording and 'rich' data in mitigating threats to validity and enhancing research reliability. Descriptive coding and content validity were utilized to evaluate the reliability of semi-structured interviews, revealing a strong level of reliability in the survey instrument, despite potential differences in measurement scales.

Result and findings

This section provides an explanation of data, hypothesis testing, and argument, ensuring the findings align with data assessments regarding respondents' distribution across various aspects. A total of 51 teachers from 29 STEM-focused preschool from Hulu Langat district participated in this research. To allow the research to choose respondents that best fit the survey's profile and collect data in a personalised method, purposive sampling was used throughout the research.



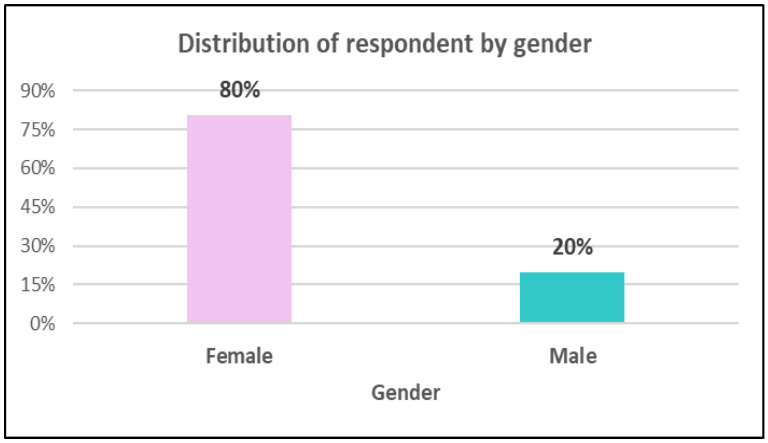
Density

	N	%
Rural	15	29.4%
Urban	36	70.6%

Figure 3

Distributions of respondents by density

The sample data in Figure 3 shows that 71% (N=36) of respondents live in urban areas, with 29% (N=15) from rural areas. This is due to the larger population densities in urban areas, which have led to the establishment of multiple preschools. Online surveys are used to access urban respondents with internet availability, ensuring data reliability and generalizability. Emphasizing density in survey research helps identify challenges and apply effective strategies.



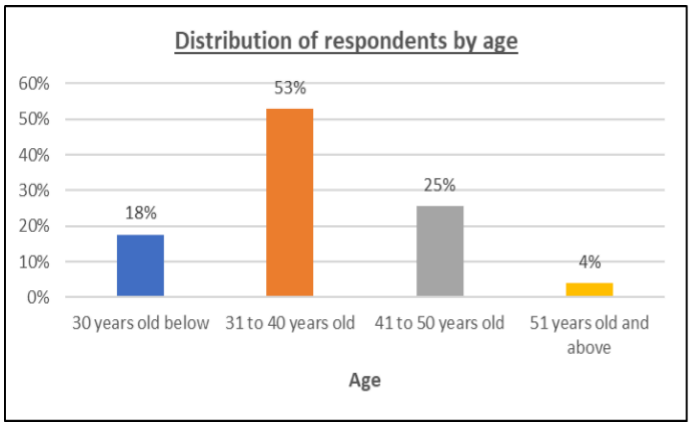
Gender

	N	%
Female	41	80.4%
Male	10	19.6%

Figure 4

Distributions of respondents by gender

Figure 4 presents data from a survey performed with 51 respondents, primarily consisted of females, with 80% (N=41) being female and 20% (N=10) being male. The gender distribution provides insight into individual experiences, responsibilities, and beliefs. Female respondents are more likely to pursue careers in preschool teaching and engage in online communities or research activities, indicating a stronger preference for females.



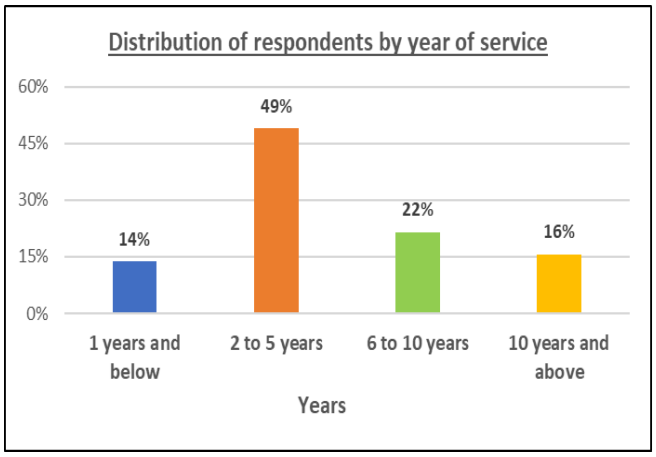
Age

	N	%
30 years old below	9	17.6%
31 to 40 years old	27	52.9%
41 to 50 years old	13	25.5%
51 years old and above	2	3.9%

Figure 5

Distribution of respondents by age

As indicated in Figure 5, the majority of respondents aged 30 and below have responded to a questionnaire, with 18% (N=9) responding. This is due to surveys focusing on subjects of interest to individuals in their thirties and forties. This age group also tends to have greater professional responsibility in their workplaces, making them more inclined towards career advancement subjects. As a result, they are more responsive to surveys, with 53% (N=27) responding between 31 and 40 years old and 25% (n=13) between 41 and 50 years old.



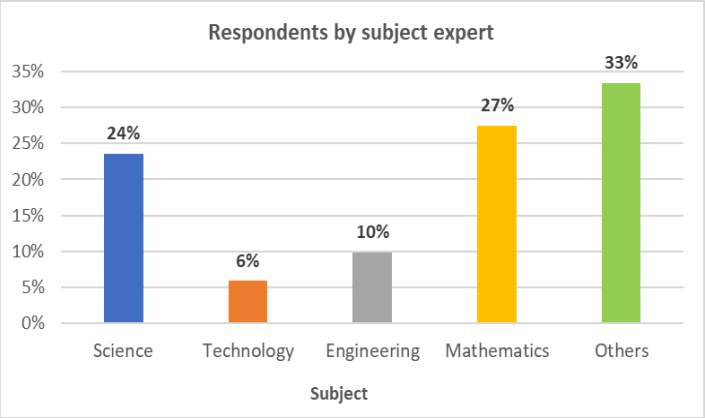
Service

	N	%
1 years and below	7	13.7%
2 to 5 years	25	49.0%
6 to 10 years	11	21.6%
10 years and above	8	15.7%

Figure 6

Distributions of respondents by year of service

Figure 6 presents an analysis of respondents according to their years of experience in the teaching field. Based on the data, 14% (N=7) of the respondents in the research survey had one year or less service in teaching field. Following that, 49% (N=25) fell between 2 to 5 years, 22% (N=11) between 6 to 10 years, and 16% (N=8) were from 10 years and above. The respondents who had a teaching experience ranging from 2 to 5 years were at the highest ranking, with a total of 49% (N=25). This phenomenon could perhaps be attributed to the inclination of teachers in their early careers to exhibit higher responsiveness towards change and innovation. These early-career teachers often sought feedback on new approaches and practices. Incorporating the length of service in the survey enhances the study's efficacy and provides insights into how experience shapes views, attitudes, and practices. The survey yields data on respondents' expertise levels, providing valuable insights into their experiences.



Respondents by subject expert

	N	%
Science	12	23.5%
Technology	3	5.9%
Engineering	5	9.8%
Mathematics	14	27.5%
Others	17	33.3%

Figure 7

Distribution of respondent by subject

In Figure 7, the graph shows that 33% (N=17) of subjects are not directly related to STEM education, with 27% (N=14) in mathematics, 24% (N=12) in science, 10% (N=5) in engineering, and 6% (N=3) in technology. This suggests a lack of competence in engineering and technology fields, potentially due to the emphasis on pedagogy and child development in early childhood education programs. The absence of subject matter specialists could lead to low-quality education in STEM fields.

Table 1

Subject expertise in cross tabulation by gender

Gender * Subject expert Crosstabulation

		Subject						
		Science	Technology	Engineering	Mathematics	Others	Total	
		N	N	N	N	N	N	%
Gender	**Female**	10	1	2	12	16	41	80.4%
	Male	2	2	3	2	1	10	19.6%
Total		12	3	5	14	17	51	100.0%

Moreover, social prejudices and gender biases influence beliefs about engineering and technology fields, leading to a decrease in highly skilled preschool teachers. Table 1 shows limited representation of male respondents in Technology and Engineering, indicating a lack of significant contribution. This differentiation is often linked to gendered conflict, with women portrayed as proficient in professions relying on social connections, and males as more capable in technical expertise.

Table 2

Distribution of academic qualifications across length of service

Academic Qualification * Length of service in teaching field Crosstabulation

		Length of service in teaching field								Total	
		1 years and below		2 to 5 years		6 to 10 years		10 years and above			
		N	%	N	%	N	%	N	%	N	%
Academic Qualification	Diploma	0	0%	3	12%	1	9%	0	0%	4	8%
	Bachelor's Degree	2	29%	7	28%	4	36%	3	38%	16	31%
	Master's Degree	3	43%	11	44%	4	36%	5	63%	23	45%
	Doctor of Philosophy	0	0%	1	4%	1	9%	0	0%	2	4%
	Others	2	29%	3	12%	1	9%	0	0%	6	12%
Total		7	100%	25	100%	11	100%	8	100%	51	100%

As indicated by Table 2, the study analyses the distribution of respondents across various academic qualifications and their length of service in the educational profession. A sample of 51 participants was analysed, with the duration of employment classified into four categories: "less than 1 year," "2 to 5 years," "6 to 10 years," and "more than 10 years." The data shows that 43% of respondents held a Master's Degree, while 36% had a Bachelor's Degree. The majority of respondents had a Master's Degree, with 63% having a tenure of 10 years and beyond. The majority of respondents held a Doctor of Philosophy degree, indicating a high level of experience. The study suggests a potential relationship between extensive teaching experience and academic qualifications, suggesting the need for teacher development programs that cater to the unique needs of teachers from diverse educational backgrounds.

Table 3

Distribution of academic qualifications across age

Academic Qualification * Age Crosstabulation

		Age									
		30 years below		31 to 40 years		41 to 50 years		51 years and above		Total	
		N	%	N	%	N	%	N	%	N	%
Academic Qualification	Diploma	1	11.1%	3	11.1%	0	0.0%	0	0.0%	4	7.8%
	Bachelor's Degree	3	33.3%	10	37.0%	2	15.4%	1	50.0%	16	31.4%
	Master's Degree	2	22.2%	9	33.3%	11	84.6%	1	50.0%	23	45.1%
	Doctor of Philosophy	0	0.0%	2	7.4%	0	0.0%	0	0.0%	2	3.9%
	Others	3	33.3%	3	11.1%	0	0.0%	0	0.0%	6	11.8%
Total		9	100.0%	27	100.0%	13	100.0%	2	100.0%	51	100.0%

Meanwhile, the data from Table 3 shows a diverse distribution of academic qualifications among preschool teachers. The age group aged 30

and younger had the highest representation, with 37% holding a Bachelor's Degree. The age group aged 41 to 50 has the highest representation, with 85% holding a Master's Degree. Two respondents aged 51 and above had different educational backgrounds, indicating a diversity in educational backgrounds. The school management should consider designing professional development programs and enhancing recruitment strategies to attract teachers with the necessary skills and expertise for STEM subjects, considering age-related perspectives and preferences.

Table 4

Descriptive statistics and reliability analysis in STEM concept readiness

Descriptive Statistics

	N	Maximum	Mean	Std. Deviation
1. I have a fundamental understanding of the STEM disciplines.	51	5	3.53	1.102
2. I have completed undergraduate education in STEM fields and have equivalent knowledge in STEM concepts	51	5	3.06	1.363
3. I have a profound and comprehensive understanding of STEM concepts.	51	5	3.29	1.238
4. I have a basic understanding of technique, method and strategies in teaching STEM.	51	5	3.53	1.155
5. I have completed undergraduate education in STEM fields and have equivalent knowledge of technique, method and strategies in teaching STEM.	51	5	3.12	1.465
6. I have a profound and comprehensive understanding of technique, method and strategies in teaching STEM.	51	5	3.29	1.285
Valid N (listwise)	51			

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.964	0.965	6

The study found that participants had a moderate to high degree of agreement with the arguments presented in the Likert-scale responses in Table 4, indicating a strong understanding of STEM principles and teaching techniques. However, there was a marginally lower agreement regarding the completion of undergraduate education in STEM subjects. The survey instrument's reliability was evaluated using Cronbach's Alpha, indicating a

high degree of internal consistency, indicating the scale's effectiveness in assessing the intended research hypothesis.

Table 5

Descriptive statistics and reliability analysis of ICT integration into teaching STEM

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
7. I refer to curriculum materials like textbooks, lesson plans, and digital tools.	51	2	5	3.94	1.008
8. I refer to technological tools for interactive learning and educational software.	51	2	5	3.94	0.947
9. I do not have any resources or materials to practice STEM teaching effectively.	51	1	4	2.24	1.069
10. I apply ICT skills with various digital tools and resources in the classroom.	51	2	5	4.18	0.865
11. I use Online learning Management System (LMS) platforms to manage and organize course content, assignments, and student progress.	51	2	5	4.06	0.881
12. I use digital assessment tools to streamline grading and provide timely feedback to students	51	2	5	4.06	0.881
13. I can find appropriate digital resources and educational technology tools that align with STEM teaching.	51	2	5	3.94	0.881
14. I do not have adequate knowledge in the use of ICT tools.	51	1	4	2.12	1.143
Valid N (listwise)	51				

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.618	0.690	8

As depicted in Table 5, the study reveals a positive attitude towards integrating ICT resources in teaching STEM subjects, with participants showing significant involvement in using educational resources and incorporating technological tools for interactive learning. However, there is a discrepancy in participants' perspectives on resource accessibility for effective STEM instruction. The study also shows a high tendency to use ICT skills in educational settings, with high scores for ICT skills

application, Online Learning Management System (LMS) platform usage, and digital assessment tools adoption. The reliability of the survey is moderate, indicating potential for professional development.

Table 6

Descriptive statistics and reliability analysis of CPD

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
15. I participate in-service training courses.	51	1	5	3.59	1.099
16. I collaborate with other teachers, both within and outside the school, to share lesson plans, teaching strategies, and best practices.	51	2	5	4.06	1.008
17. I often attend/engage workshop, seminars and trainings that focused on STEM and staying up-to-date in CPD.	51	1	5	3.59	1.043
18. I provide and involve with collaboration and networking that focuses on STEM as part of my CPD.	51	2	5	3.53	0.987
19. I engaged in educational research and publication in STEM teaching and learning as part of my CPD.	51	1	5	3.18	1.352
20. I am facing challenges in accepting professional development.	51	1	5	2.29	1.285
Valid N (listwise)	51				

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.719	0.745	6

Thorough investigation as shown in Table 6, examines the attitudes and participation in professional development programs related to STEM education. Participants reported average engagement in in-service training courses and collaboration with other teachers. They were more likely to attend STEM conferences, seminars, and trainings. They also provided professional services, participated in networking, and produced publications in STEM settings. However, they had difficulties accepting professional growth. The reliability statistic showed high dependability even with variations in measurement scales. 39 participants were interviewed to investigate challenges affecting STEM educational settings readiness and CPD.

1. What are the challenges that you face in your current profession in acquiring the complete STEM framework?

	N	%
Absence of Interdisciplinary Knowledge	3	7.7%
Lack of technological advancements	18	46.2%
Limited access to resources	6	15.4%
Time constraint	12	30.8%

2. What are the possible actions to work around the limitation to acquire STEM framework?

	N	%
Collaborative learning	9	23.1%
Continuous professional development	15	38.5%
Mentorship	9	23.1%
Online educational resources	6	15.4%

3. Which technology approaches have been proved to be effective in teaching STEM currently?

	N	%
Coding and programming tools	7	17.9%
Digital classroom	5	12.8%
Online interactive learning apps	21	53.8%
Online simulation tools	6	15.4%

4. How to improve the effectiveness of current ICT practices?

	N	%
Community of practice	5	12.8%
Competency standards	3	7.7%
Enhancement of ICT infrastructure	14	35.9%
Hands-on Trainings	11	28.2%
User-centered design	6	15.4%

5. What are the limitation to acquire ICT Skills in your current profession?

	N	%
Fear of technology	9	23.1%
Inadequate internet access	8	20.5%
Inadequate proficiency	7	17.9%
Limited training resources	12	30.8%
Time constraint	3	7.7%

6. What are the possible solution of having insufficient resources and materials?

	N	%
Allocation of financial resources	6	15.4%
Inadequate technological resources	14	35.9%
Networking to facilite exchange of information	13	33.3%
Self-initiated efforts to seek out resources	6	15.4%

7. How do you participate in professional development in the present situation?

	N	%
Functional courses	3	7.7%
Increased duties and responsibilites	3	7.7%
In-house trainings	14	35.9%
Networking	7	17.9%
Participation in professional development actvities	6	15.4%
Self-paced learning	2	5.1%
Skill based trainings	4	10.3%

8. What are the challenges that you are facing in accepting professional development?

	N	%
Challenge of work-life balance	7	17.9%
Lack of motivation	5	12.8%
Limited resources	12	30.8%
Organizational changes	2	5.1%
Time constraint	9	23.1%
Transformation in teaching strategies	4	10.3%

Figure 8

Percentage distributions of challenges based on semi-structural interview

Based on the statistic in Figure 8, the study reveals that obtaining the full STEM framework presents numerous challenges, including technological advancements, time constraints, lack of interdisciplinary knowledge, and limited resource access. Preschool teachers are often unprepared and inexperienced, leading to a lack of preparedness and capability in STEM teaching. In the meantime, the discussion is corroborated by the result if the interview, a teacher who teach technology stated that:

> *"I teach technology, but it's challenging for me to do so because I didn't have my degree in that field. I must have further guidance about the concept of teaching technology".*

Consequently, the findings suggest that future research should focus on examining STEM theory and practices, enrolling teachers in graduate

courses, evaluating teaching methods, and addressing technological barriers. It also suggests interdisciplinary training programs to enhance pre-school teachers' understanding of the entire STEM framework. The study found that continuous professional development, collaborative learning, mentorship, and online instructional tools are effective methods for addressing limitations in acquiring the complete STEM framework. Meanwhile, the subsequent questionnaire sought to discover the effective technological methods for teaching STEM subjects.

The results also showed a diverse range of approaches, with online interactive learning applications being the most popular (53.8%). Strategies for improving existing ICT practices were suggested, including enhancing infrastructure, providing hands-on training, recognizing community of practice, user-cantered design, and competency standards. Barriers to acquiring ICT skills included limited training resources (30.8%), fear of technology (23.1%), and inadequate internet access (20.5%). Techniques to overcome these challenges included inadequate technology resources, establishing networks for information exchange (33.3%), allocating financial resources (15.4%), and adopting self-initiated effort (15.4%). In-house trainings were the most common method, followed by networking, professional development activities, skill-based trainings, and self-paced learning. Interviews revealed challenges in accepting opportunities for professional growth, including lack of resources (30.8%), time constraints (23.1%), and work-life balance concerns (17.9%). School management should consider implementing measures to alleviate these struggles, evaluate organizational support, and assess the effectiveness of personalized professional development initiatives. Whereby, in the situations where

teachers are unable to preserve work-life balance, one of the female interviewees stated that:

> *"I have many things on my plate, with lesson planning, grading and administrative tasks. And, I find it challenging to find time for my family because the duties of teaching extend beyond regular school hours".*

Additionally, one more interviewee from a different school stated:

> *"In addition to teaching in the classroom, I also have to show up to meetings and take part in committee activities at the school. Almost all of the activities took place after school hours".*

Furthermore, the study indicated that 41 out of 51 respondents are female, suggesting the need for flexible work schedules for female teachers. The research also highlights a lack of highly qualified STEM teachers in preschools, indicating a need for recruitment and ongoing professional development. The findings suggest that school administrators should consider these factors to improve work-life balance and enhance teachers' understanding of STEM concepts.

Recommendations

The study findings suggest the integration of soft skills into STEM education methods so as to bridge the knowledge gap in engineering and technology fields. Preschool educators can enhance their acquisition of soft skills through various strategies, including inviting guest speakers or professionals to share experiential knowledge. Play-based learning activities, such as robotic coding and building blocks, can engage children and foster skills like creativity, confidence, teamwork, system thinking, and ethical considerations.

Additionally, teachers can engage in action research projects to enhance STEM teaching through soft skills. However, the study revealed a lack of safety protocols during STEM activities. Prioritizing safety, age-appropriateness, and alignment with children's developmental stages is crucial. Teachers should undergo professional training to stay updated with safety regulations in STEM educational practices. Further research could explore safety regulations, including the use of non-hazardous materials and adequate first aid training. Integrating safety protocols into preschool STEM teaching can create a secure, supportive, and intellectually stimulating educational environment, ensuring children's safety and facilitating effective learning experiences. Emphasizing safety standards and professional practices is recommended by schools, teacher training institutions, and STEM educators, as suggested by Love, Duffy, Loesing, Roy, and West (2020).

Limitation

Despite its limitations, this study effectively addressed the research hypotheses and problem statement by obtaining interview data from voluntary schools in the Hulu Langat district. However, the findings may not be generalizable to all school districts or states. Additionally, the survey included participants from various fields of study, not limited to STEM subjects, making it challenging to draw specific conclusions regarding the impact of each element individually.

Conclusion

The literature review highlights a lack of ICT skills expertise among preschool teachers, potentially hindering their readiness to teach STEM lessons. Teachers often perceive technology as a barrier to STEM-based education, a concern addressed by analysing the causes of technology phobia, as discussed by Shidiq and Nasrudin (2021). Currently, in-house training is the primary strategy for professional development opportunities. Understanding these preferences can aid in designing customized approaches. Professional development training can enhance teachers' expertise in areas such as subject knowledge, planning, and career development. The research initiative aims to equip highly skilled teachers with resources to teach STEM courses in preschools using diverse creative concepts, aligning with the findings of Nguyen and Redding (2018) that recruiting STEM graduates with the necessary skills and expertise can improve the quality of STEM education.

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