Pertanika J. Soc. Sci. & Hum. 33 (1): 395 - 425 (2025)

SOCIAL SCIENCES & HUMANITIES

Journal homepage: http://www.pertanika.upm.edu.my/

Towards Designing a Project-Based Learning-Technology Based Learning (PBL-TBL) Science Module to Promote Social Interaction Among Preschool Children with the Integration of Blended Learning Approach

Azam Ghazali[1], Zakiah Mohamad Ashari[1]*, Joanne Hardman[2] and Sri Wiji Handayani[3]

[1]*School of Education, Faculty of Educational Sciences and Technology, Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, Malaysia*
[2]*School of Education, Faculty of Humanities, University of Cape Town, Rondebosch 7700, South Africa*
[3]*Labschool Universitas Negeri Semarang, Sekaran, Central Java 50229, Indonesia*

ABSTRACT

The declining number of Malaysian students opting for the science stream has impacted the country's global PISA ranking. This paper presents the development of a Project-based Learning-Technology-based Learning (PBL-TBL) science module for preschool children, aiming to foster early interest in science through collaborative activities. The study employs a mixed-method design, incorporating three phases of the ADDIE Model: needs analysis, design, and development. In the needs analysis phase, interviews were conducted with nine preschool educators to assess the necessity of the module. During the design phase, six experts evaluated the prototype to ensure its effectiveness. The development phase involved nine experts assessing the usability of the MyPraSains learning module, specifically designed for Malaysian preschools. In the implementation phase, 25 preschoolers engaged in an activity from the module to test its practical application. Finally, the evaluation phase involved an educator interview to assess the module's impact based on expert feedback. Findings revealed that experts unanimously agreed on the validity of the MyPraSains module, achieving a content validity index (CVI) of 1.00. Additionally, children demonstrated significant social development through active participation in module activities. Educators also endorsed the module, recommending its adoption in preschool settings as a benchmark for science education

ARTICLE INFO

Article history:
Received: 11 June 2024
Accepted: 04 November 2024
Published: 27 March 2025

DOI: https://doi.org/10.47836/pjssh.33.1.18

E-mail addresses:
muhammad.nur.azam@graduate.utm.my (Azam Ghazali)
zakiahma@utm.my (Zakiah Mohamad Ashari)
joanne.hardman@uct.ac.za (Joanne Hardman)
sriwiji@mail.unnes.ac.id (Sri Wiji Handayani)
*Corresponding author

ISSN: 0128-7702
e-ISSN: 2231-8534

quality in Malaysia. This study highlights the potential of early science exposure in nurturing long-term interest in STEM fields, addressing the ongoing decline in science stream enrolment.

Keywords: Learning module, preschool, project-based learning, science education, technology-based learning

INTRODUCTION

The social interaction development of children is significantly affected by various factors such as the individual, gender, parental roles, and preschool settings. A strong correlation exists between social skills and happiness in childhood (Rossano et al., 2022). The cultivation of environmental acceptance and the cultivation of positive emotions during social activities are fundamental characteristics that hold significant importance in fostering a prosperous and pleasurable future existence (Mayar, 2013). The early stages of children's social development exhibit variations between girls and boys (Sjöman et al., 2021). Research suggests that girls tend to demonstrate faster development compared to boys (A. H. Mohamed, 2018). However, it is worth noting that the preschool setting can offer a fair and equitable environment that provides children with opportunities for development through positive engagement in social activities (Sjöman et al., 2021). Furthermore, incorporating engaging interactive social activities, such as using interactive teaching materials, can effectively facilitate positive interpersonal relationships among preschool educators during learning and facilitating sessions (Luen, 2017).

Moving on, debating the use of technology in education settings, several research have demonstrated that it is a platform to produce the elements of 21st-century learning (Tripathi et al., 2023). Technology integration has been envisioned to support the development of 21st-century skills and abilities in teaching and learning life sciences. Educators specifically mentioned that the use of technology in the science classroom helps children improve critical thinking, problem-solving, interaction, teamwork, and computational thinking skills (Ramaila & Molwele, 2022). Besides, by utilising digital tools in the classroom, educators and children can acquire new information, abilities, and experiences (Demir & Akpinar, 2018). Furthermore, exposing children to technology-based learning (TBL) will help them learn about things outside their assumptions and thinking boxes. When juxtaposed with the impact of technological innovation on the transformation of society and the social lives of individuals outside the classroom, the metamorphosis of learning through the incorporation of technology has gained traction (Ilomäki & Lakkala, 2018). On the other hand, according to Tomar and Sharma (2022), this approach may reduce educators' costs by experience, offering children a tech-centred world, fostering better relationships between children through collaborative behaviour, and keeping children interested and engaged.

As a result, the integration of PBL and TBL in science classrooms is not only promoting children to gain new knowledge related to the concepts of science, but it can also enhance the collaboration of child peers (Markula & Aksela, 2022).

Problem Statements

Educators in the preschool context have the responsibility of implementing science instruction in preschool. However, few educators have recently expressed their ability to take on the duty, but they have also highlighted certain problems that arise while attempting to apply the learning process. A study by Ramli et al. (2017) revealed that educators continue to exhibit inadequate readiness to implement science instruction. Furthermore, upon closer discussion of the context of early childhood education, A. Ghazali et al. (2024) have elucidated that early childhood educators experienced significant apprehension when conducting early science activities. This is primarily due to their limited teaching proficiency and inadequate grasp of scientific concepts. This can be backed by the findings of Daud's (2019) study, where she mentioned that early childhood education educators' knowledge is moderate in undertaking high-impact activities. This situation suggests a challenge for them to delve deeper into new knowledge, such as researching more complex science concepts and understanding physics topics. More profoundly, a qualitative study by Leung (2023) revealed that the primary reasons for the inability of teachers to enhance the quality of early science education are attributed to insufficient knowledge of suitable teaching methodologies, lack of experience in executing science activities, deficiencies in classroom management, inadequate instructional resources, and infrastructural limitations. Thus, this notion has demonstrated that educators' grasp of mastering knowledge has not been able to promote the development of children's learning skills.

Moreover, the absence of tangible resources in schools contributes to the deterioration of preschool science education quality (Barenthien & Dunekacke, 2022). To support this nation, a study conducted by Han et al. (2022) has revealed that rural schools, in particular, have serious problems in implementing practical science activities compared to urban schools because they do not have access to materials to implement them. On top of that, Abdul Rasid (2022) disclosed that educators are unable to provide the most notable instruction possible due to their perception that the resources available to them are inadequate and that it is hard to provide children with the chance to explore their learning in a collaborative and transparent manner. Although the difficulties mentioned seem common in today's education system, these challenges will have a huge impact on the future of children since the actions done by science educators in early schooling will determine the direction and concentrate on the creation and preparation of society for the future (Garzón, & Díaz-Moreno, 2019). As a result, M. N. A. Ghazali and Yusof (2022) emphasised the use of hands-on activities to ensure children's learning about science concepts is successfully implemented. This includes the application of PBL by incorporating TBL, which is critical because it can increase concentration and focus on children and encourage them to acquire new experiences. More thoroughly, A. Ghazali et al. (2023) emphasised that the most fundamental use of technological resources in the classroom environment is to offer children educational video displays that help them understand concepts more completely and precisely.

This study will highlight five research topics arising from the problems highlighted, including:

i. What are the needs for developing the PBL-TBL Science Module in early childhood education?
ii. What key aspects must be included in the design of the PBL-TBL Science Module to support the social development of children's interactions?
iii. How effective is the development of the PBL-PBL Module in promoting children's social development through interactions?
iv. Is there a difference in children's social interaction development before and after using the MyPraSains Module?
v. What is the significance of the MyPraSains Module in fostering the social development of children's interactions?

Literature Review

In early childhood education, teaching and facilitation activities need to be creatively implemented by educators to ensure that children can improve their development holistically. To flourish and attain professional satisfaction, the preschool educator needs to acquire knowledge about teaching approaches so that children can grasp basic skills before entering the mainstream (Abdullah et al., 2021). As a result, one of the most effective attempts is to include the PBL approach in preschool scientific instruction. Previous studies revealed that PBL is an effective approach for immersing children in the real world of the twenty-first century, according to numerous research studies (Tamim & Grant, 2013). In addition, a prior study by Ilangko (2014) discovered that the PBL he carried out helped children develop and enhance their capacity for creative thought. From these findings, it could be synthesised that PBL is a systematic learning strategy that allows students to enhance their abilities and receive in-depth knowledge through the execution of the project, collaboration, and 'hands-on' procedures (Du & Han, 2016). Children can also cooperate with the educator by applying what they have learned to create an outcome that addresses the investigated issue or solves the desired problem (Shukri et al., 2019). Furthermore, as demonstrated by Sumarni et al. (2022), PBL has the potential to enhance children's understanding as they work through educator-prepared projects. It can also foster cooperation, interaction, and communication between students and educators, as well as between students and peers. Finally, PBL can help children develop compassionate and understanding friendships through the completion of projects together.

To ensure the effectiveness of science classrooms for the development of children's interaction, Donnelly (2005) mentioned several times in his study that the use of PBL-TBL encourages children to socialise collaboratively and assists children in interacting with friends and peers about the learning topic under study. This notion is supported by the findings of the study by Al-Abdullatif and Gameil (2021), who discovered that the integration of these two approaches is able to facilitate adaptable and swift conversation (useful), which results in effective interaction and cooperation between leaners-peers. These situations lead to the successful completion of the project. As a result, using technology-based resources in educational settings, as well as incorporating them into practical project activities, can encourage children to explore the world by providing access to a wide range of information and broadening project tasks. Many previous research projects might corroborate the findings of individual engagement's effects on learning while using technology in PBL activities (Egilmez et al., 2018). As a result, educators have to recognise how to merge these two approaches in the science of learning. Additionally, Purnama et al. (2023) determined that the ideal practice that educators may use is blended learning.

However, in general, this approach is the closest to the traditional one because it involves technology in the classroom. It is appropriate for use in classes with children at different levels. According to Tomar and Sharma (2022), this approach may reduce educators' costs by enabling modern learning in a more advanced setting, fostering children's involvement in their educational experience. It also offers children a tech-centred world, fostering better relationships between children through collaborative behaviour and keeping children interested and engaged. This approach scientifically proves that it can boost children's social development and provide features of 21st-century education, such as allowing children to actively participate in more open discussions among peers through exchanging ideas (Lalima & Dangwal, 2017). More profoundly, Medeiros et al. (2017) further highlighted that adopting PBL tasks through blended learning enabled learners to take on responsibility, and they discovered that collaborative tools might facilitate coaching sessions, discussions, and feedback. In order to support this statement, Mabe et al. (2022) indicate that the integration of PBL-TBL fosters an individual's 4C skills: communication, cooperation, creativity, and critical thinking. Additionally, integrating technology into the educational experience facilitates robust linkages to the real world, another essential element of PBL.

Moving on, from a worldwide standpoint, the implementation of the PBL-TBL strategy offers numerous advantages to children. A study conducted by Chistyakov et al. (2023) has demonstrated that educators who effectively implement PBL activities by incorporating technology into STEM education are capable of enhancing the critical thinking skills of Russian children through hands-on activities conducted in school. Furthermore, Indonesian children engaged in PBL-TBL activities have demonstrated progress from multiple perspectives. The findings indicated an enhancement in creative thinking abilities in terms of flexibility, elaboration, fluency, and originality. According to Suryandari (2021), engaging in the PBL-TBL activity has a beneficial impact on enhancing creative thinking skills. Furthermore, a study conducted by Miller et al. (2021) has demonstrated that American educators have expressed favourable opinions regarding the use of PBL-TBL for teaching science. This approach allows children to learn from their educators and provides opportunities for them to learn with the community through the technology tools incorporated into the curriculum. Moreover, while considering the viewpoint of children in Brazil, the enhancement of education through PBL-TBL can amplify their drive by providing a significant and impactful learning engagement. They recognised that this method enhances their individual learning through investigation and allows them to collaborate in researching and creating projects demonstrating their knowledge (Medeiros et al., 2017).

Moreover, Yeop and Gapor (2012) have elucidated that PBL-TBL is crucial in the Malaysian education system as it benefits learners' academic performance. Specifically, there is a notable disparity between the average test scores after implementing PBL-TBL and the average test scores before its implementation for each child. Furthermore, research has demonstrated that this strategy is effective in positively impacting learners, regardless of their gender. In addition, while examining the children's receptiveness to learning a subject at school using the PBL-TBL strategy, they have displayed a favourable response, indicating a high degree of acceptability towards this approach. Furthermore, the research conducted by Kiong et al. (2022) has demonstrated that incorporating learning modules in Malaysian schools that employ the PBL-TBL approach is highly valued by education experts. This approach is seen as significant as its components have the ability to foster children's engagement and interest in the learning process. However, exploring more captivating modules that incorporate module design elements such as Arial font and multi-colour, provide text in bullet points, adhere to A4 size, and include visual illustrations is advisable. In order to provide clearer evidence of the effectiveness of this PBL-TBL module, it is crucial for educators to allow children to engage in direct activities. According to Tee et al. (2020), the PBL-TBL approach fails to achieve its objectives when children are unable to generate a problem-solving product due to a lack of ability to express their ideas effectively. Therefore, it is imperative for educators to facilitate children's learning by offering them chances to engage in collaborative project-based activities both inside and outside the classroom. This will enhance their motivation to master many disciplines, particularly early science topics.

Theoretical Framework

In the context of the current study, the role of ECE educators is the most important role for children to wisely conduct the activities associated with PBL-TBL. The educator carries out a series of learning by organising a sequence that begins with the creation and preparation of learning and ends with the implementation and evaluation of a series of learning actions implemented in ECE centres (Safitri et al., 2018). Additionally, Cunningham et al. (2015) emphasised that it is hypothesised that to properly mediate children's development, educators need to have a broad range of content knowledge. Educators, in particular, must be aware of the traits and competencies of the 21st century, which include information, media, and technology skills, learning and innovation skills, and life and career skills, in order to successfully carry out a project intended for children (Kafka & Papageorgiou, 2025). In the current study, researchers created an effective learning module for children using the PBL Process Model, which outlines five major steps educators must take to scaffold children when adopting PBL activities at preschool (Barak, 2020). The initial step involves problem identification, followed by problem investigation, technological device planning, construction and troubleshooting of the implemented project, and ultimately concluding with project evaluation. Furthermore, prior research recommended that educators should adhere to during the mediation process in the classroom, the theoretical work of sociocultural learning theory by Vygotsky (1978) will be thoroughly examined.

In the current study, the educator needs to clearly understand three elements related to TBL. Firstly, educators should be ready to serve as pedagogical innovators in the classroom and at the school (Alvarado & Voy, 2006) by making topics and projects more engaging. Secondly, the content provided by the tools should be appropriate for children's development (Lentz et al., 2014). Thirdly, educators should understand the role of children as "innovation" explicitly. When individuals refer to "innovation," they are not limited to the use of computers or other technology-based teaching tools. While technological improvements are a part of innovation, innovation involves much more than just technology ("Educators are innovators", n.d.). The next step in the mediation process in PBL is to construct and troubleshoot the problem after they fully understand the three components of TBL. This step is frequently applied when producing any project to identify the root cause of faulty completed projects. This step is also taken to fix rejected goods and identify the underlying causes of issues so unsuccessful goods can be repaired and used again. In terms of project implementation in kindergarten, if children cannot solve a problem for the first time, the concept of trial and error is a simple concept that can be understood about how children solve problems through the troubleshooting method. Last but not least, the final step is to do the evaluation phase. The evaluation could be done by giving feedback. Allowing peer dialogue between educator-children and child-peers can enhance the understanding of the learning goals through feedback.

METHODS

This study used a mixed-methods design involving data collection from several sources, including surveys and interviews, without necessarily integrating them into a singular analysis (Peez, 2023). This study employs the ADDIE model (Shakeel et al., 2023) as a supplementary foundation, comprising five essential phases for the development of the MyPraSains Learning Module. In each phase, researchers utilised a single research instrument without integrating it with other instruments, such as data collection through the triangulation of several datasets. Technically, during the first phase, known as the needs analysis phase, researchers conducted a series of interview protocols to gather qualitative data on educators' perspectives on the significance of designing children's PBL science learning modules in preschool settings. Furthermore, during the second phase, known as the module design phase, researchers distribute a survey to experts to solicit crucial components that should be incorporated into the learning module. In addition, as part of the third phase, known as the module development phase, experts were also provided with a questionnaire to assess the efficacy of the module in promoting the social development of children's social interactions. In addition, during the fourth step, referred to as the implementation phase, researchers utilised both a pre-test and a post-test to evaluate the usefulness of the MyPraSains module for preschool children that consisted of a treatment and control group. In addition, as part of the fifth phase, known as the evaluation phase, a series of protocols are employed to conduct interviews with educators who have utilised MyPraSains in their learning and facilitation process. Once researchers systematically use the data collection approach based on these five steps, establishing the learning module can be actualised (Bacotang & Isa, 2016).

Research Participants

For the appointment of study participants in all phases, researchers employed the purposive sampling technique, which signifies a collection of non-probability sampling procedures in which units are selected because they have qualities that researchers need in your sample (Palinkas et al., 2015). Furthermore, the second sampling technique employed in the needs analysis phase is snowball sampling (Heckathorn, 2011), which is a recruitment approach in which study participants are invited to help researchers identify new possible subjects. During this phase, researchers recruited nine educators with diverse backgrounds to participate in the study. During the design and development phase, the researcher has chosen six experts in the field of education to participate in the study. According to Abdelmohsen et al. (2020), the module can be developed with the competence of just five experts. Nevertheless, the researchers chose to select six experts for the design phase and nine experts for the development phase to enhance the significance of the gathered data. Furthermore, during the implementation phase, the chosen study participants consisted of 25 preschool children, particularly between the ages of 5 and 6. In addition, during the evaluation phase, only one preschool educator was selected to participate in the activity implementation session as part of the evaluation module. Table 1 provides a general overview of the backgrounds of all the participants and experts selected for this study.

Table 1
Background of study participant in Phase 1: Needs analysis

Participant	Position	Teaching Education	School Type/Area
1	Preschool Educator	More than 5 Years	Government/Rural
2	Preschool Educator	More than 5 Years	Government/Rural
3	Preschool Educator	More than 5 Years	Government/Rural
4	Preschool Educator	More than 10 Years	Government/Rural
5	Preschool Educator	More than 15 Years	Private/Urban
6	Preschool Educator	More than 5 Years	Government/Rural
7	Preschool Educator	More than 10 Years	Government/Urban
8	Preschool Educator	More than 5 Years	Government/Rural
9	Preschool Educator	More than 5 Years	Government/Urban

Table 2
Background of study participant in Phase 2: Module design

Participant	Position	Teaching Experience	Field
1	PhD., Lecturer	More than 15 Years	Early Childhood Education
2	PhD., Lecturer	More than 5 Years	Early Childhood Education
3	PhD., Child Consultant	More than 15 Years	Curriculum Development
4	PhD., Lecturer	More than 5 Years	Child Psychology
5	Excellent Preschool Educator	More than 15 Years	Child Psychology
6	Preschool Excellent Educator	More than 5 Years	Curriculum Development

Table 3
Background of study participant in Phase 3: Module development

Participant	Position	Teaching Experience	Field
1	PhD., Lecturer	More than 15 Years	Early Childhood Education
2	PhD., Child Partitioner	More than 15 Years	Child Psychology
3	PhD., Lecturer	More than 5 Years	Curriculum Development
4	PhD., Lecturer	More than 15 Years	Child Psychology
5	PhD., Lecturer	More than 10 Years	Pedagogy in Education
6	PhD., Lecturer	More than 10 Years	Early Childhood Education
7	PhD., Lecturer	More than 10 Years	Early Childhood Education
8	PhD., Lecturer	More than 10 Years	Early Childhood Education
9	PhD., Lecturer	More than 15 Years	Educational Psychology

Table 4
Background of study participant in Phase 4: Module implementation

Participant	Position	Experience	Preschool
1	Preschool Teacher	Teaching more than 15 years	A
2	25 preschoolers	Learning at formal school for approximately 1–2 years	A

Table 5
Background of study participant in Phase 5: Module evaluation

Participant	Position	Experience	Preschool
1	Preschool Teacher	Teaching more than 15 years	A

The samples from preschool educator backgrounds were selected based on a minimum of five years of preschool teaching experience and possessing at least a diploma in education (Tables 1 and 5). According to Table 4, the participants were chosen from two distinct preschools situated in Bachok District, Kelantan. Based on Tables 2 and 3, the experts were selected based on their proficiency in diverse disciplines. The rationale for selecting experts from diverse disciplines is that module development encompasses various processes; content creation is primarily the domain of early childhood education experts, module formulation is the purview of educational curriculum and pedagogical experts, and activity design is chiefly the responsibility of educational psychological experts. Furthermore, preschool children were selected based on their experience as a preschooler for at least 1 year.

Research Instruments

Deciding on suitable instruments for data collection is a vital stage in the research process (Bastos et al., 2014). An instrument is a device used to gather specific data to address a predetermined research question. Instrumentation refers to the act of equipping with equipment or devices that are used to gather data. In this study, researchers employed five distinct research instruments (Tables 6, 7, 8, 9, and 10) to address five specific research questions.

Table 6
Constructs and items for research instrument in Phase 1: Needs analysis

Instrument	Construct	No. of Item
Interview Instrument: The Perception of Preschool Educators Towards Integrating PBL-TBL in Science Activities	Challenges in teaching early science	1
	Integrating National Preschool Curriculum Standard (KSPK) 2017 with PBL Activities	1
	The Best Approach could be utilised to teach early science	1
	The importance of the PBL approach for social interaction	1

Table 7
Constructs and items for research instrument in Phase 2: Module design

Instrument	Construct	No. of Item
Questionnaire Instrument: Designing PBL-TBL-based Science Learning Module to improve Children's Social Interaction	Activity implementation	2
	Types of activity	1
	Learning objective	1
	Use of worksheet	1
	Use of technology tools	1
	Time allocation	1
	Challenge of activity	1
	Guideline in classroom	1

Table 8
Constructs and items for research instrument in Phase 3: Module development

Instrument	Construct	No. of Item
Questionnaire Instrument: Evaluation of PBL-TBL-based Science Learning Module in improving Children's Social Interaction	Technological needs	2
	Learning and facilitation objective	2
	Module contents	2
	Activities slots	2

Table 9
Constructs and items for research instrument in Phase 4: Activity implementation

Instrument	Construct	No. of Item
Pre and Post-Test Instruments for Assessment of Children's Social Interaction Development	Cooperation	5
	Self-control	5
	Assertiveness	5

Table 10
Constructs and items for research instrument in Phase 5: Activity evaluation

Instrument	Construct	No. of Item
Interview Instrument: The Perception of Preschool Educators Towards the Effectiveness of MyPraSains Module in the Learning and Facilitation Process	Social encouragement of interaction in learning	1
	Challenges while using the module	1
	Suggestions for future classes	1

Data Collection

For quantitative data collection protocol, especially for the design and development phase, each expert was provided with a form with a specific reference number UTM.J.53.01.00/13.11/1/4/2 Vol. 16, which was used to appoint them. Once researchers gained consent from the participants, they proceeded with the data collection process using empirical methods. In addition, for the qualitative data collection protocol, each study participant was given a volunteering form as a participant to engage in the interview session. On the other hand, for the quantitative data collection protocol, especially for the implementation phase, researchers were permitted by the Malaysian Ministry of Education (MoE) and the State Department of Education to carry out this study. Then, this permission form was given to the school for a physical data collection session.

Data Analysis

In order to appropriately analyse the acquired data and answer research questions (RQ) 1, researchers utilised theme analysis with the assistance of the ATLAS.ti Software. This approach helped to clarify the results drawn from the conducted interviews. In order to enable the successful creation of themes, researchers employed the inductive reasoning approach, which involves commencing the process without any predetermined beliefs or codes, allowing patterns, themes, and categories to emerge organically from the data. The researchers encoded the data to capture any notions or patterns that appeared intriguing or significant to the study inquiry (Hecker & Kalpokas, 2024). In contrast, the researchers utilised content validity index analysis (CVI) in Excel software to address RQ2 and RQ3. This analysis aimed to assess the experts' perception of the contents within the intended and developed module. To address RQ4, the researchers employed a paired-sample t-test to assess the disparity between the pre-and post-usage of the MyPraSains Module by the children. The researchers employed IBM SPSS Statistics software to analyse the data. Finally, in response to RQ5, the researchers exclusively employed content analysis based on the available interview transcript data. Microsoft Word was utilised to emphasise the responses obtained from interviews, as the study participants consisted of only one teacher, precluding the thematic content analysis approach.

RESULTS

Phase 1: Need Analysis for PBL-TBL Science Learning Module

Construct 1: Challenges in Teaching Early Science

As highlighted by 21st-century education, preschool educators face numerous challenges in effectively implementing science instruction. These challenges have been shaped by educators' personal beliefs and external influences. Figure 1 illustrates seven themes that the researchers effectively studied. The key issues will be emphasised through explanations of these themes.

Seven topics have been successfully documented to understand the genuine challenges educators and preschool children face in ensuring that early science learning is implemented effectively. The first theme that was most commonly reported was that four participants (P) stated that they were not provided with or did not have adequate equipment to conduct quality science activities at preschool. The following interview findings support this:

P1: "Furthermore, I intend to instruct on the topic of balloon bursting at my location tomorrow. However, acquiring enough materials is a significant challenge for me. This is a remote location, and it is rather distant if I wish to depart from here."

P3: "In my perspective, the materials we offer are limited, and the children must collaborate with us to prepare for projects, such as botanical science."

P4: "And the other is related to the material used. The majority of individuals, uh, this is a common occurrence. The majority of my acquaintances from the preschool division heavily rely on paper-based modules for teaching. They abstain from utilising any form of substance. That is the issue I perceive. That is all."

P8: "The biggest challenge is in terms of preparing materials. If we want to perform an inquiry, we use things that are not in the classroom. We must locate it by ourselves."

Furthermore, the second successfully recorded theme was a shortage of time to conduct high-quality scientific activities. P8 and P3 have reported that they must participate in other activities, which limits their ability to focus on science activities. Furthermore, the third theme recorded was language, with P4 stating that the use of terminology in science differs from the terms used in common language at home, which prompts children to struggle with such terms. Besides, the fourth successfully documented theme was lack of knowledge, with P1 and P7 arguing that it was about the best approach to offer PBL activities while incorporating parts of 21st-century education. The sixth theme was successfully recorded as a lack of confidence, in which P2 states that children felt afraid in attempting to solve issues in science activities, resulting in the inability to complete the activity. In addition, the sixth theme that was successfully documented was age inequality among children, and P6 stated that it is challenging to execute the same activities for all children because she must monitor the growth of each child individually. The final theme that was successfully documented was the children's lack of concentration, as P5 and P9 described how difficult it was to regulate the children and ask them to focus when doing science tasks in class.

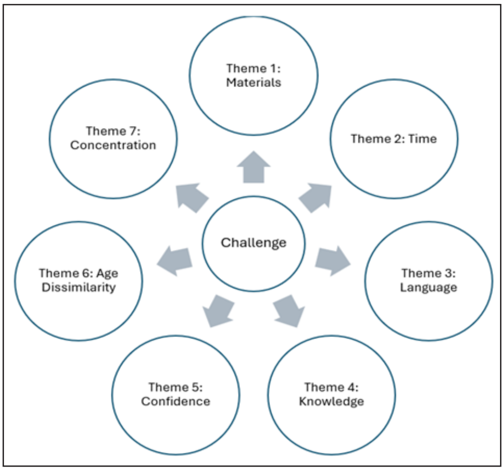

Figure 1. Challenges in teaching science in preschool

Construct 2: Integrating National Preschool Curriculum Standard (KSPK) 2017 with PBL-TBL Activities

All study participants (P1-P9) expressed positive agreement on the ethical integration of KSPK 2017 with PBL activities. However, only two of the nine participants agreed that KSPK 2017 should be conditionally integrated with PBL activities, resulting in two distinct. According to P1, P2, P3, P5, P7, P8, and P8, they believed that introducing PBL activities in preschools using KSPK 2017 content is appropriate due to the importance of this PBL approach (see construct 4) for the development of children's social interactions as they participate in impactful classroom activities. However, P4 and P6 emphasised in the interviews that this integration should be performed conditionally for the following reasons:

> P4: "That's all right, but it depends on the circumstances. It will take some time, just like me, and the preparation of the project. It's recommended that we take our time."

> P6: "To be honest, I believe that it is sometimes relevant to be implemented and sometimes it is not. According to the first viewpoint, the children's level varies. Perhaps the integration of PBL with KSKP 2017 can be carried out directly in the urban environment but not in rural areas."

Construct 3: The Best Approach Could be Utilised to Teach Early Science

Before designing the module, researchers have to figure out which approach should be favoured so that educators can generate quality learning. Five themes were successfully recorded. From the 11 codes that were successfully assessed in nine independent interviews, four participants, namely P5, P7, P8, and P9, confidently claimed that the integration of science education is consistent with the PBL approach. This is because this approach has its own advantages compared to other approaches, such as the debates below:

> P5:"Typically, if I want to carry out a project, I would love to use existing, real materials. For example, if I wish to undertake an experimental activity, the teaching aids utilised must be interesting. We must provide them with engaging material, and our voice must be absolutely clear."

> P7:"So, the approach I chose in my project is the 3E approach, which I will encourage my learners to reveal to explore, experiment, and experience."

> P8:"In our preschool, I have not been limited to following the timetable, so I will be using a project approach entirely. So, when using the full project approach in my instruction session, I guess this approach could provide an investigation. So, this time is when educator,,,, urmmm,, children do an investigation in a project approach."

> P9:"Example of making a project. Project. The simplest for preschool children is to plant seeds. Right? The process is the easiest; materials are easily available, and they can see progress day by day. The peanut seeds germinated."

Furthermore, the second theme successfully analysed is the theme of the inquiry approach, where P1, P8, and P9 agreed that inquiry is a key component in ensuring early science learning can be implemented through hands-on experiences. They claimed this method will pique children's interest in completing a task. Furthermore, the third theme that was successfully investigated was the approach of learning through play, where P2 and P6 stated that allowing children to play in science learning increases their motivation to learn. The fourth and fifth themes successfully recorded were the thematic and integrated approaches. P4 explained that the fourth theme is important because children must understand a concept in accordance with appropriate themes. Meanwhile, P3 stated that the third theme is important to ensure that the implemented activities produce high-impact learning outcomes.

Construct 4: The Importance of the PBL Approach for Social Interaction

To assess preschool educators' perceptions of previous experiences and their abilities to evaluate the value of the PBL approach in early science activities, they were asked about the strength of this approach to the social development of children's interaction. Through their sharing, several codes were effectively recorded in four different themes. For analysing these themes, researchers only emphasised several codes from successfully recorded themes because researchers in the design phase of the learning module emphasised all these themes. For theme one, which is two-way communication, P1, P5, P7, P8, and P9 emphasised that in science activities using the PBL approach, children's engagement with educators or peers becomes more active. This can be demonstrated by P5's experience, which follows:

> P5:"When I do projects with my preschool children, they love to keep talking. I mean, he or she is eager to speak up. Everyone wants to talk to educator and want to tell what they see in front of their eyes. Meaning, if we ask, they will share their opinion."

Furthermore, for the second theme, joyful in learning, P2, P3, and P9 demonstrated that implementing projects in the classroom can assist children in acquiring fun and burden-free learning. This is supported by P3's perspectives and experiences, which are as follows:

> P3: "Their engagement with friends is still manageable because they are still able to participate in the activities thoroughly and have fun in the class."

In addition, for the third and fourth themes, which are the many ways interaction and increase in socialisation, only P3 and P4 commented on them. P3 believed that theme 3 arises when learners socialise with others in their group while engaging in collaborative learning. Furthermore, P4 claimed that theme 5 is significant to children because the PBL approach itself can improve children's motivation to interact more openly with their friends. This can be proven by the dialogues below:

> P5:"It means that when we introduce children to PBL activities, they can interact with friends and also they can tell what is being done. It means they will be well-socialised with friends through collaborating together."

> P6:"When self-motivation increases through doing projects so that it can enhance their social interaction."

Phase 2: PBL-based Science Learning Module Prototype Design

For the second phase, the six experts (E) received an evaluation instrument, a prototype PBL-based science learning module called MyPraSains, and a prototype of the educator's guideline. According to the conclusions acquired by the researchers, all the experts in the field expressed very positive feedback about the design of this module, where only Agree (A), Agree Strongly (AS), and Agree Very Strongly (AVS) scale was given for each item. This can be seen by their concordance in all constructs and items, as explicated in Table 11. As an essential remark, the process utilised to address the second research question is identical to the process employed by researchers to answer the third research question, as both utilise the same technique for implementing the research instrument and calculating agreement.

To compute the agreement among experts for each item, the researchers first divide each agreement scale into two parts, which are parts of agreement and disagreement, as suggested by Yusoff (2019) in Table 12.

The researchers will then gather agreement scales for each item in two categories: relevant or irrelevant. This relevant or non-relevant category is determined using the Item Level-Content Validity Index (I-CVI), and the Scale Level-Content Validity Index (S-CVI) is generated by calculating the amount of agreement for those individual items. In summary, the researchers acquired favourable agreement for this study, and only relevant categories were recorded, as shown in Table 13.

Table 11
Construct, item, and experts' agreement in Phase 2

No.	Construct/Item	Expert Agreement					
		E1	E2	E3	E4	E5	E6
	Construct 1						
1.	Item 1: Variety of Activities through Learn by doing.	AS	AS	AS	AVS	AS	A
	Item 2: Teaching and facilitation scheduled and formatted.	AS	A	AS	AVS	AS	A
	Construct 2						
2.	Item 1: State the type of project clearly.	AS	AS	AS	AVS	AS	A

Table 11 *(continue)*

No.	Construct/Item	Expert Agreement					
		E1	E2	E3	E4	E5	E6
	Construct 3						
3.	Item 1: Appropriateness of earning objective.	AS	A	AS	AS	AS	A
	Construct 3						
4.	Item 1: Appropriate Worksheet.	AS	A	AS	AVS	AS	A
	Construct 5						
5.	Item 1: Technology accessible to use the module in the classroom.	AS	A	AS	AS	AS	A
	Construct 6						
6.	Item 1: Appropriate time to implement the activity within 40 minutes.	AS	A	AS	AS	A	A
	Construct 7						
7.	Item 1: Appropriate challenge with child development.	AS	AS	AS	AVS	AS	A
	Construct 8						
8.	Item 1: Provide guidelines to implement the activity.	AS	AS	AS	AVS	AS	A

Table 12
Agreement, instruction, and category

Instruction		
Agreement	**Scale**	**Category**
Disagree Very Strongly (DVS)	1	0
Disagree Strongly (DS)	2	0
Disagree (D)	3	0
Agree (A)	4	1
Agree Strongly (AS)	5	1
Agree Very Strongly (AVS)	6	1

Table 13
I-CVI and S-CVI for findings in Phase 2

Item	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	I-CVI	Category	S-CVI
1	5	5	5	6	5	4	1	Relevant	1
2	5	4	5	6	5	4	1	Relevant	1
3	5	5	5	6	5	4	1	Relevant	1
4	5	4	5	5	5	4	1	Relevant	1
5	5	4	5	6	5	4	1	Relevant	1
6	5	4	5	5	5	4	1	Relevant	1
7	5	4	5	5	4	4	1	Relevant	1
8	5	5	5	6	5	4	1	Relevant	1
9	5	5	5	6	5	4	1	Relevant	1

Table 14
Modified Kappa coefficient (K) obtained based on content validity indexing in Phase 2

Sum of I-CVI	**9**	**Sum of S-CVI**	**9**
Sum of I-CVI/Ave: (Total I-CVI/Total of Item)	1	Sum of I-CVI: (Total I-CVI/Total of Item)	1
Category	Accepted		Accepted

To calculate the total of the I-CVI index and the total of S-CVI, the researchers utilised the formula suggested by Polit et al. (2007), which is demonstrated in Table 14. The final results suggest that the experts' overall coefficient value for S-CVI is positively achieving $k = 1$. It signifies that each expert obtained all items positively and reached an accurate consensus.

Subsequently, based on the feedback provided by each expert concerning the prototype design of this educational module, a consensus is reached that prioritises and condones a methodology more suited to preschool settings.

Phase 3: MyPraSains Module Development

In the third phase, the six experts (E) were provided with an evaluation instrument, a constructed science learning module called MyPraSains based on PBL, and a comprehensive guideline for educators. Based on the input obtained by the researchers, all the experts in the field indicated highly positive feedback regarding the efficacy of this module. The experts were only provided with a scale consisting of Agree (A), Agree Strongly (AS), and Agree Very Strongly (AVS) options for each topic. This can be seen by their concordance in all constructs and items, as explicated in Table 15. As an essential remark, the process utilised to address the second research question is identical to the process employed by researchers to answer the third research question, as both utilise the same technique for implementing the research instrument and calculating agreement. Following that, the researchers gathered agreement scales for each item in two categories: relevant or irrelevant, as explained in Table 16.

Table 15
Construct, item, and experts' agreement in Phase 3

No.	**Construct/Item**	**Expert Agreement**								
		E1	**E2**	**E3**	**E4**	**E5**	**E6**	**E7**	**E8**	**E9**
	Construct 1									
1.	Item 1: Laptops and LCDs in the classroom.	AS	A	AS	AS	A	A	AS	AVS	AS
2.	Item 2: Internet facility.	AS	A	AS	AS	AVS	AVS	AS	AVS	AS
	Construct 2									
3.	Item 1: Objectives focus on the 2017 National Preschool Standard Curriculum (NPSC 2017).	AS	AS	AS	AS	AVS	AVS	AS	AVS	AS

Table 15 *(continue)*

No.	Construct/Item	Expert Agreement								
		E1	E2	E3	E4	E5	E6	E7	E8	E9
4.	Item 2: Objectives that can be assessed based on the level of the child.	AS	AS	AS	AS	AVS	AS	AS	AS	AS
	Construct 3									
5.	Item 1: The content is suitable according to the level of knowledge of children.	A	AS	AS	AS	AVS	AVS	AVS	AS	AS
6.	Item 2: Content relevant to children's development.	A	AS	AS	AS	AVS	AS	AVS	AS	AS
	Construct 4									
7.	Item 1: Interactive activities help children communicate with each other.	AVS	AS	AS	AS	AVS	AVS	AS	AS	AS
8.	Item 2: Activities can help group problem-solving.	AS	AS	AS	AS	AVS	AVS	AS	AS	AS

Table 16
I-CVI and S-CVI for findings in Phase 3

Item	E1	E2	E3	E4	E5	E6	E7	E8	E9	I-CVI	Category	S-CVI
1	5	4	5	5	4	4	5	6	5	1	Relevant	1
2	5	4	5	5	6	6	5	6	5	1	Relevant	1
3	5	5	5	5	6	6	5	6	5	1	Relevant	1
4	5	5	5	5	6	5	5	5	5	1	Relevant	1
5	4	5	5	5	6	6	6	5	5	1	Relevant	1
6	4	5	5	5	6	5	6	5	5	1	Relevant	1
7	6	5	5	5	6	6	5	5	5	1	Relevant	1
8	5	5	5	5	6	6	5	5	5	1	Relevant	1

To determine the combined value of the I-CVI index and the total value of the S-CVI, the researchers employed the formula shown in Table 14. The end result in Table 17 indicates that the experts' overall coefficient value for S-CVI has successfully reached a value of $k = 1$. This proves that every expert received each thing positively and achieved a precise consensus.

Table 17
Modified Kappa coefficient (K) obtained based on content validity indexing in Phase 3

Sum of I-CVI	**8**	**Sum of S-CVI**	**8**
Sum of I-CVI/Ave: (Total I-CVI/Total of Item)	1	Sum of I-CVI: (Total I-CVI/Total of Item)	1
Category	Accepted		Accepted

After receiving feedback from each expert regarding the usefulness of the generated module, a consensus is achieved that prioritises and approves a methodology better suited for preschool settings. Nevertheless, E3, an expert in the field, proposed that to guarantee this module's long-term efficacy, teachers must consistently oversee and assess the progress of the children's growth during the activities.

Phase 4: Activity Implementation during 8-Week Intervention

To address this research inquiry, the researchers initially computed the pre- and post-test results for every study participant. The educator assessed the pre-test scores prior to the commencement of the activity and provided the post-test score once the activity was over.

Additionally, researchers have discovered that utilising the MyPraSains Module helps enhance children's social development by examining the disparity between pre and post-test scores as mentioned in Table 18. The information can be accessed by referring to the Table 19 provided.

Table 19
Paired samples test

Paired Samples Test									
	Paired Difference							Significance	
				95% Confidence Interval of the Difference					
Comparison score (post and pre-tests)	Mean	Std. Dv	Std. Error Mean	Lower	Upper	t	df	One-Sided p	Two-Sided p
	-25.24	7.63	1.53	-28.39	-22.10	-16.55	24	<.001	<.001

A value of 001 signifies that the likelihood of achieving the observed result by random chance is lower than 0.1%. Put simply, there

Table 18
Pre and post test score

Participant	Pre-Test Score	Post-Test Score
1	36.00	64.00
2	45.00	70.00
3	36.00	70.00
4	30.00	60.00
5	45.00	55.00
6	43.00	55.00
7	36.00	65.00
8	45.00	65.00
9	43.00	60.00
10	39.00	60.00
11	36.00	65.00
12	45.00	70.00
13	36.00	65.00
14	30.00	60.00
15	45.00	60.00
16	43.00	60.00
17	36.00	60.00
18	36.00	65.00
19	45.00	70.00
20	36.00	70.00
21	30.00	70.00
22	45.00	70.00
23	43.00	60.00
24	36.00	65.00
25	33.00	70.00

is compelling evidence indicating that the outcomes are not a consequence of random chance and are statistically significant. Utilising the MyPraSains Module has a very beneficial impact on the social development of children's interactions. The children demonstrated a proactive communication approach during the activity.

Phase 5: Activity Evaluation based on Development of Children's Social Interaction

Based on data collected directly from PE1, she has thoroughly explained the MyPraSains Module's effectiveness in preschool child development. She observed that the activities in this module not only helped children address the tasks presented in the activity, but she highlighted that those children also stimulated communication while doing so. The following transcript supports this:

> PE1: "I was taken aback the first time I engaged in this activity with children." Typically, students exhibit limited enthusiasm during scientific tasks, but on this occasion, they appeared notably enthusiastic in their efforts to finish the assigned assignment. Um, um... Not only did they successfully finish the task of constructing buildings in their various groups, but I also saw that they had sufficient time to discuss and exchange ideas with their peers regarding their creations. In my perspective, this is positive feedback."

In addition, in terms of the challenges faced by her in using this module, she explained that there were difficulties with the allotted time. Researchers only allocated 40 minutes of time for each activity, but she explained that 1 hour was the most appropriate time because the children showed happy feelings throughout the activity. This can be proven through the transcription below:

> PE1: "Urmmm, How can I say is,,,, urmm, from my observation, children in my class display a high level of enthusiasm and engagement during the activities. Despite the time constraints imposed by the module, the children displayed a remarkable level of excitement and delight throughout the activities. As a result, I had to allocate additional time for them to finish each sub-activity during the process of constructing the building. In my opinion, a duration of 40 minutes is acceptable, but if the allocated time is extended to 1 hour, it would greatly facilitate the learning process and eliminate any sense of haste."

Furthermore, when discussing the educator's perspectives and suggestions regarding the implementation of this module in Malaysian preschools, she expressed her confidence that this module has the capacity to effectively enhance social development and interactions within the school environment. Furthermore, she clarified that it is imperative to promote this module in all preschools, regardless of whether they are government or private institutions. This is because the interactive activities offered within the module can foster collaborative thinking among children. As evidence, it can be referred to the transcription below:

> PE1"In my personal opinion,,, you know what,,, urmm,,, I have a strong affinity for this module." Not only does it foster collaborative interaction and engagement among children, but it also stimulates their ability to think creatively and unconventionally. I strongly advocate for the use of this module by all preschool instructors in Malaysia in order to enhance the quality of science instruction at the preschool level on a daily basis."

DISCUSSION

Through the views of the educators in this present study, the PBL module is essential in preschool education today since it can enhance children's social development through their engagement in early science activities inside or outside the classroom. This is supported by the findings of N. N. Mohamed and Jaafar's (2020) study. They stated that providing a PBL learning module to educators in science education in preschool allows children to socialise and communicate with educators and friends. This includes those activities more openly and transparently because the topics introduced are based on 21st-century learning elements. On the other hand, Ompok et al. (2020) argued that introducing a science learning module through the PBL approach in preschool increases children's curiosity about new concepts. It also increases children's confidence in questioning and answering critical problems initiated by the educator. Furthermore, Aziz and Bakar (2021) discovered that the PBL science module is appropriate for promotion in early childhood because collaborative classroom learning can help children develop their creativity. Otherwise, Hsin and Wu (2023) discovered that the educator's function as a facilitator and role model in the classroom encourages children's experimentation since the educator becomes a resource for children to socialise in meaningful activities.

Next, keeping in consideration the success of PBL features in early childhood education, experts have expressed their belief that a learning module based on PBL-TBL will assist children in improving their social development through group activities. However, Elviana et al. (2022) noted that the educator's knowledge of applying these two ways is critical to ensuring that the children understand the content to be presented. Cooperative work in PBL has the potential to enhance children's communication and teamwork skills, leading to considerable improvements in their overall development (Parrado-Martínez & Sánchez-Andújar, 2020). Upon further synthesis, these two approaches greatly facilitate social interactions that hold immense importance for children. Considering the PBL approach first is helpful, as Aulia et al. (2024) explained that PBL can allow children to learn cooperatively with peers. Meanwhile, Kim and Kim (2021) discovered that when children start doing projects in groups, their social interaction becomes passive. Hence, the findings imply that the responsibilities of individuals within a group should be modified to accommodate the specific attributes of problem-based learning (PBL) and the nature of the work. Furthermore, when considering the significance of incorporating technology into education, independent of the specific technologies employed in the classroom, it can provide support for students' comprehension and learning during science-based activities that include inquiry (Devolder et al., 2012). Therefore, to succeed in science education classes, educators must adopt a more systematic approach by incorporating technology tools, such as proper models and guidelines (Zahner, 1998).

In general, introducing attractive and interactive learning modules into the education system attracts children to learn (Sirisuthi & Chantarasombat, 2021). In addition to improving children's communication and interaction skills, using learning modules incorporating PBL and TBL in the classroom will assist children in grasping the concepts taught to them (Artiniasih et al., 2019). Furthermore, Oksa and Soenarto (2020) noted that educators' efforts to implement learning utilising electronic media in conjunction with the execution of science activities at school could stimulate children to take out activities with greater confidence. Next, to explain why PBL-TBL in blended learning is important, the results of this study also confirmed the findings of the current study, in which one of the experts indicated that the existence of this MyPraSains Module can assist children in developing an interest in science subjects. More profoundly, Yustina et al. (2020) argued that incorporating PBL into a blended learning environment has a significant impact on creating a more active and interactive classroom. As a result, integrating blended learning demonstrates that it has the ability to improve both children's social development and the overall quality of the learning environment (Graham et al., 2023). According to a study conducted by AlAli and Wardat (2024), the promotion of technology within the context of science education in schools has been found to be one of the most effective factors in enhancing children's PISA performance. According to previous reports, experts have reached a consensus that engaging in technology-related activities can enhance children's motivation to learn science. Their interest in science will be indirectly correlated with their future PISA performance, resulting in improved scores.

Last but not least, when considering improvements to enhance the quality of science education using the PBL-TBL approach, participants in phase 5: Evaluation Module have recommended that the optimal duration for conducting science activities through the MyPraSains module should be 60 minutes. The educator elaborated that allocating 60 minutes as a period of tranquillity allows youngsters to engage in things more creatively without the pressure of completing them within a restricted timeframe. Curran and Kitchin (2019) provided evidence that allocating sufficient time for science activities can benefit children's development. The allocation of sufficient learning time is crucial, surpassing the significance of the number of topics to be taught to children. This is because children require a profound comprehension of a subject matter rather than merely gaining a multitude of new knowledge within a limited timeframe.

CONCLUSION

Experts have reached a consensus that educators would greatly benefit from developing a comprehensive science PBL-TBL learning module. This will help educators overcome the challenges they face when attempting to create high-quality early science activities for preschoolers. In addition, children learn to work together in a PBL-TBL environment to solve problems that relate to multiple scientific concepts. This improves their motivation to participate in science activities and encourages them to use their creative and critical thinking skills to solve problems arising from these activities. The existence of this learning module in science education would improve educators' abilities to create a more competent learning environment, resulting in a better generation for the future. However, priority should be made to providing support from the MoE in enhancing the preschool curriculum to improve the quality of education. Furthermore, from an educational perspective, it is imperative for teachers to consistently take proactive measures to implement problem-based learning and task-based learning activities to enhance their teaching abilities progressively. Nevertheless, it is imperative to conduct longitudinal studies to observe the progress and growth of children's accomplishments over time, using educational modules that are implemented in the official schooling system.

Limitation and Recommendation

Several limitations have emerged as the primary obstacle to guaranteeing appropriate data collection. One initial limitation is the reliance on voluntary participation of individuals in the study. Initially, researchers sought preschool educators from a range of government and private organisations from rural and urban areas to participate in this study. Nevertheless, most research participants in phase 1, the Needs Analysis, are teachers not from the urban area. Nevertheless, three out of nine educators originate from urban regions. This is due to the use of the snowball sampling technique, whereby most research participants recommended by existing participants are teachers employed in either rural or suburban areas (in proximity to the town within a district). Despite the imbalance between urban and rural educators, researchers have devised identical interview questions requiring them to elucidate their answers based on their experiences in teaching science and discuss the obstacles they encounter in science education. The study's findings indicate that both groups of educators concurred on the high utility and significance of employing the TBL-PBL module for teaching science to preschool children in both rural and urban areas. The second limitation is related to the selection of field experts. Initially, researchers conducted a survey among multiple experts in the field of education to ensure their participation in developing and producing high-quality learning modules. However, the survey data indicates that only experts in early childhood education, educational pedagogy, curriculum development, and educational psychology are interested in participating in this undertaking. While they possess diverse areas of competence, some also possess additional particular expertise, such as actively creating educational modules for preschool children and authoring books on instructional technology in education. It is recommended that future studies involve the selection of experts in different fields, such as educational technology, to assess their reaction to the technology-based learning module that has been established.

The findings that have been obtained show two recommendations that researchers can highlight. The first thought is that current research is seen to be able to bridge the gap between past studies empirically. As proof, the result from the experts' consensus focused that the development of this PBL-TBL science learning module could provide more opportunities for children to improve their social interaction through cooperative activities. It also helps them solve the problems associated with classroom activities through the empowerment of creative thinking. The reason behind this is that, according to Ucar (2015), incorporating technology into the classroom allows for the simulation of real-world problems, which in turn promotes more authentic learning in science classrooms. In addition, this present study also recommends that future studies focus more on observations of how preschool children adapt to learning hands-on science activities in blended learning settings. The reason why this situation should be seriously emphasised is that it was proven that using a practical approach while teaching science could help educator strengthen their knowledge related to practising good teaching approaches over time. At the same time, it is also able to create a benchmark for the MoE to promote the integration of early science education in a more open and transparent manner. Hence, the MoE should fully back efforts to enhance preschool teachers' technological competence since many educators attribute the blended learning model's success to the resources they have at their disposal (Bruggeman et al., 2021).

ACKNOWLEDGEMENT

The authors disclosed receipt of the following financial support for the research, writing, and publishing of this article: This project was fully funded by the UTM Nexus Scholarship.

REFERENCES

Abdelmohsen, M. M. (2020). The development and validation of a module on enhancing students' critical thinking, collaboration and writing skills. *SAR Journal, 3*(4), 166-177. https://doi.org/10.18421/SAR34-04

Abdul Rasid, N. (2022). *Views, practices and challenges of preschool educators on the application of higher-level thinking skills through play activities in the early science component* [Unpublished doctoral dissertation]. Universiti Sains Malaysia.

Abdullah, M. M., Nor, M. M., & Hutagalong, F. D. (2021). Play teaching approach in the classroom among preschool educators. *Journal of Educational Research, 39*, 64-74.

Al-Abdullatif, A. M., & Gameil, A. A. (2021). The effect of digital technology integration on students' academic performance through project-based learning in an e-learning environment. *International Journal of Emerging Technologies in Learning, 16*(11), 189-210. https://doi.org/10.3991/ijet.v16i11.19421

AlAli, R., & Wardat, Y. (2024). Low PISA performance students: Factors, perceptions, and improvement strategies. *International Journal of Religion, 5*(9), 334-348. https://doi.org/10.61707/nve8gj33

Alvarado, F., & Voy, D. L. (2006). *Educators: Powerful innovators*. Academy for Educational Development Global Education Center.

Artiniasih, N. K. S., Agung, A. A. G., & Sudatha, G. W. (2019). Project-based module electronic development Science subject class viii for first secondary school. *Jurnal EDUTECH Universitas Pendidikan Ganesha, 7*(1), 54-65.

Aulia, M. P., Sudarti, & Zar'in, F. (2024). Implementation of project based learning method in developing cognitive abilities of children aged 5-6 years through loose parts media. *Journal of Education and Teaching Learning, 6*(1), 106-118. https://doi.org/10.51178/jetl.v6i1.1793

Aziz, C. N. F. C. A., & Bakar, K. A. (2021). Fostering children's creativity through preschool STEM Creativity Module. *International Journal of Academic Research in Progressive Education and Development, 10*(3), 176-189. https://doi.org/10.6007/IJARPED/v10-i3/10403

Bacotang, J., & Isa, Z. M. (2016). The development of early literacy module for children's nurseries. *Jurnal Pendidikan Awal Kanak-Kanak Kebangsaan, 5,* 30-48.

Barak, M. (2020). Problem-, project- and design-based learning: Their relationship to teaching science, technology and engineering in school. *Journal of Problem-Based Learning, 7*(2), 94-97. https://doi.org/10.24313/jpbl.2020.00227

Barenthien, J. M., & Dunekacke, S. (2022). The implementation of early science education in preschool educators' initial educator education. A survey of educator educators about their aims, practices and challenges in teaching science. *Journal of Early Childhood Educator Education, 43*(4), 600-618. https://doi.org/10.1080/10901027.2021.1962443

Bastos, J. L., Duquia, R. P., González-Chica, D. A., Mesa, J. M., & Bonamigo, R. R. (2014). Field work I: selecting the instrument for data collection. *Anais brasileiros de dermatologia, 89*(6), 918-923. https://doi.org/10.1590/abd1806-4841.20143884

Bruggeman, B., Tondeur, J., Struyven, K., Pynoo, B., Garone, A., & Vanslambrouck, S. (2021). Experts speaking: Crucial teacher attributes for implementing blended learning in higher education. *The Internet and Higher Education, 48,* Article 100772. https://doi.org/10.1016/j.iheduc.2020.100772

Chistyakov, A. A., Zhdanov, S. P., Avdeeva, E. L., Dyadichenko, E. A., Kunitsyna, M. L., & Yagudina, R. I. (2023). Exploring the characteristics and effectiveness of project-based learning for science and STEAM education. *Eurasia Journal of Mathematics, Science and Technology Education, 19*(5), Article 2256. https://doi.org/10.29333/ejmste/13128

Cunningham, A. E., & Ryan O'Donnell, C. (2015). Teacher knowledge in early literacy. In A. Pollatsek & R. Treiman (Eds.), *The Oxford Handbook of Reading* (pp. 447-462). Oxford University Press.

Curran, F. C., & Kitchin, J. (2019). Early elementary science instruction: Does more time on science or science topics/skills predict science achievement in the early grades? *AERA Open, 5*(3). https://doi.org/10.1177/2332858419861081

Daud, K. M. (2019). Challenges of preschool educators in applying STEM Education. *Jurnal Pendidikan Sains & Matematik Malaysia, 9*(2), 25-34. https://doi.org/10.37134/jpsmm.vol9.2.4.2019

Demir, K., & Akpinar, E. (2018). The effect of mobile learning applications on students' academic achievement and attitudes toward mobile learning. *Malaysian Online Journal of Educational Technology, 6*(2), 48-59. https://doi.org/10.17220/mojet.2018.04.004

Devolder, A., van Braak, J., & Tondeur, J. (2012). Supporting self-regulated learning in computer-based learning environments: Systematic review of effects of scaffolding in the domain of science education. *Journal of Computer Assistant Learning, 28*(6), 557-573. https://doi.org/10.1111/j.1365-2729.2011.00476.x

Donnelly, R. (2005). *Using technology to support project and problem-based learning using technology to support project and prob.* Technological University Dublin.

Du, X., & Han, J. (2016). A literature review on the definition and process of project-based learning and other relative studies. *Creative Education, 7,* 1079-1083. https://doi.org/10.4236/ce.2016.77112

Educators are innovators: Educators and school leaders transforming education. (n.d.). Childhood Education International. Retrieved on October 18th, 2023, from https://ceinternational1892.org/educators-are-innovators/

Egilmez, G., Sormaz, D., & Gedik, R. (2018, June 24-27). A project-based learning approach in teaching simulation to undergraduate and graduate students. *2018 ASEE Annual Conference & Exposition*. American Society for Engineering Education. https://doi.org/10.18260/1-2--29716

Elviana, V. R., Sintawati, M., Bhattacharyya, E., Habil, H., & Fatmawati, L. (2022). The effect of project-based learning on technological pedagogical content knowledge among elementary school pre-service educator. *Pegem Journal of Education and Instruction, 12*(2), 151-156.

Garzón, A., & Díaz-Moreno, N. (2019). The teaching of science in the childhood stage: Difficulties, challenges, and new methodological proposals. In *ICERI2019 Proceedings* (pp. 8339-8344). IATED. https://doi.org/10.21125/iceri.2019.1981

Ghazali, A., Ashari, Z. M., Hardman, J., Omar, R., & Handayani, S. W. (2023). Best practices in STEM education for preschool children: A case study in Malaysia. *Sains Humanika, 16*(1), 87-99. https://doi.org/10.11113/sh.v16n1.2102

Ghazali, A., Ashari, Z., M., Hardman, J., & Yazid, A. A. (2024). Development and effectiveness of the E–Sky Module based on PBL in the teaching and facilitation process of early science. *Journal of Baltic Science Education, 23*(2), 221-239. https://doi.org/10.33225/jbse/24.23.221

Ghazali, M. N. A., & Yusof, M. (2022). Achieving quality learning through STEM education towards kindergarten educators' perceptions. *Jurnal Pendidikan Awal Kanak–Kanak Kebangsaan, 11*(1), 108-119. https://doi.org/10.37134/jpak.vol11.1.10.2022

Graham, C. R., & Halverson, L. R. (2023). Blended learning research and practice. In O. Zawacki-Richter & I. Jung (Eds.), *Handbook of Open,* *Distance and Digital Education* (pp. 1159-1178). Springer. https://doi.org/10.1007/978-981-19-2080-6_68

Han, C. G. K., Amatan, M. A., & Lai, E. (2022). Experiment implementation with interest in science learning in under-enrolled schools of Kota Belud District, Sabah. *Malaysian Journal of Social Sciences and Humanities, 7*(8), Article 001668. https://doi.org/10.47405/mjssh.v7i8.1668

Heckathorn, D. D. (2011). Snowball versus respondent-driven sampling. *Sociological Methodology, 41*(1), 355-366. https://doi.org/10.1111/j.1467-9531.2011.01244.x

Hecker, J., & Kalpokas, N. (2024). Handling qualitative data: The ultimate guide to qualitative research - Part 2. *Atlas.ti.* https://atlasti.com/guides/qualitative-research-guide-part-2/qualitative-data-analysis

Hsin, C. T., & Wu, H. K. (2023). Implementing a project-based learning module in urban and indigenous areas to promote young children's scientific practices. *Research in Science Education, 53,* 37-57. https://doi.org/10.1007/s11165-022-10043-z

Ilangko, S. (2014). *The effect of the approach of integrating creative thinking skills in teaching descriptive essays and imaginative essays among students form five* [Unpublished doctoral dissertation]. Universiti Sains Malaysia.

Ilomäki, L., & Lakkala, M. (2018). Digital technology and practices for school improvement: Innovative digital school model. *Research and Practice in Technology Enhanced Learning, 13,* Article 25. https://doi.org/10.1186/s41039-018-0094-8

Kafka, D., & Papageorgiou, T. (2025). The pedagogy of skills in the 21st century: Practices for integrating them into the teaching process. *Creative Education, 16*(1), 56-70. https://doi.org/10.4236/ce.2025.161004

Kim, H. W., & Kim, M. K. (2021). A case study of children's interaction types and learning motivation in small group Project-based Learning activities in a mathematics classroom. *Eurasia Journal of Mathematics, Science and Technology Education, 17*(12), Article 2051. https://doi.org/10.29333/ejmste/11415

Kiong, T. T., Mohd Rusly, N. S., Abd Hamid, R. I., Singh, C. K. S., & Hanapi, Z. (2022). Inventive problem-solving in project-based learning on design and technology: A needs analysis for module development. *Asian Journal of University Education, 18*(1), 271-278.

Lalima, & Dangwal, K. L. (2017). Blended learning: An innovative approach. *Universal Journal of Educational Research, 5*(1), 129-136. https://doi.org/10.13189/ujer.2017.050116

Lentz, C. L., Seo, K. K., & Gruner, B. (2014). Revisiting the early use of technology: A critical shift from "how young is too young?" To "how much is 'just right'?" *Dimensions of Early Childhood, 42,* 15-23.

Leung, W. M. V. (2023). STEM education in early years: Challenges and opportunities in changing educators' pedagogical strategies. *Education Sciences, 13*(5), Article 490. https://doi.org/10.3390/educsci13050490

Luen, L. C. (2017). Puppets as pedagogical tools in social development and emotion of preschool children. *Jurnal Pendidikan Awal Kanak-Kanak Kebangsaan, 6*(1), 45-56. https://doi.org/10.37134/jpak.vol6.1.4.2017

Mabe, A., Brown, K., Frick, E. J., & Padovan, F. (2022). Using technology to enhance project-based learning in high school: A phenomenological study. *Education Leadership Review of Doctoral Research, 10,* 1-14.

Markula, A., & Aksela, M. (2022). The key characteristics of project-based learning: How educators implement projects in K-12 science education. *Disciplinary and Interdisciplinary*

Science Education Research, 4, Article 2. https://doi.org/10.1186/s43031-021-00042-x

Mayar, F. (2013). Social development of early children as seeds for the nation's future. *Al-Ta'lim Journal, 20*(3), 459-464. https://doi.org/10.15548/jt.v20i3.43

Medeiros, F. P., Júnior, P., Bender, M., Menegussi, L., & Curche, M. (2017). Blended learning experience applying project-based learning in an interdisciplinary classroom. In *ICERI2017 Proceedings: 10th annual International Conference of Education, Research and Innovation* (pp. 8665-8672). IATED. https://doi.org/10.21125/iceri.2017.2364

Miller, E. C., Reigh, E., Berland, L., & Krajcik, J. (2021). Supporting equity in virtual science instruction through project-based learning: opportunities and challenges in the era of COVID-19. *Journal of Science Teacher Education, 32*(6), 642-663. https://doi.org/10.1080/1046560X.2021.1873549

Mohamed, A. H. (2018). Gender as a moderator of the association between educator-child relationship and social skills in preschool. *Early Child Development and Care, 188,* 1711-1725. https://doi.org/10.1080/03004430.2016.1278371

Mohamed, N. N., & Jaafar, A. N. M. (2020). Use of project-based learning inquiry learning module for 4 years old children. *Jurnal Pendidikan Awal Kanak-Kanak Kebangsaan, 9,* 73-90. https://doi.org/10.37134/jpak.vol9.sp.8.2020

Oksa, S., & Soenarto, S. (2020). Project-based e-module development to motivate vocational school students' learning. *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran, 4*(1), 99-111. https://doi.org/10.21831/jk.v4i1.27280

Ompok, C., Sapirai, J., Emison, E., Teo, L, & Payne, P. K. (2020). Developing an animal STEM module using a project approach for preschool children. *International Academic Research Journal of Social Science, 6*(2), 6-16.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health, 42*(5), 533-544. https://doi.org/10.1007/s10488-013-0528-y

Parrado-Martínez, P., & Sánchez-Andújar, S. (2020). Development of competences in postgraduate studies of finance: A project-based Learning (PBL) case study. *International Review of Economics Education, 35,* Article 100192. https://doi.org/10.1016/j.iree.2020.100192

Peez, A. (2023). Is multi-method research more convincing than single-method research? An analysis of international relations journal articles, 1980-2018. *Security Studies*, *33*(1), 55-87. https://doi.org/10.1080/09636412.2023.2262388

Polit, D. F., Beck, C. T., & Owen, S. V. (2007). Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Research in Nursing & Health, 30*(4), 459-467. https://doi.org/10.1002/nur.20199

Purnama, H. I., Wilujeng, I., & Abdul Jabar, C. S. (2023). Blended learning in elementary school science learning: A systematic literature review. *International Journal of Evaluation and Research in Education, 12*(3), 1408-1418. https://doi.org/10.11591/ijere.v12i3.25052

Ramaila, S., & Molwele, A. J. (2022). The role of technology integration in the development of 21st century skills and competencies in life sciences teaching and learning. *International Journal of Higher Education, 11*(5), 91-17. https://doi.org/10.5430/ijhe.v11n5p9

Ramli, A. A., Ibrahim, N. H., Surif, J., Bunyamin, M. A. M., Jamaluddin, R., & Abdullah, N. (2017). Educators' readiness in teaching stem education. *Man in India, 97*(13), 343-350.

Rossano F., Terwilliger, J., Bangerter A., Genty E., Heesen, R., & Zuberbühler, K. (2022).

How 2- and 4-year-old children coordinate social interactions with peers. *Philosophical Transactions of the Royal Society B, 377,* Article 20210100. http://doi.org/10.1098/rstb.2021.0100

Safitri, M., Wahyuni, S., & Putra, Z. A. (2018). Implementation of the development of moral religious values in early childhood through modeling methods. *Early Childhood Research Journal, 6*(3), 325-340.

Shakeel, S. I., Al Mamun, M., & Haolader, M. (2023). Instructional design with ADDIE and rapid prototyping for blended learning: Validation and its acceptance in the context of TVET Bangladesh. *Education and Information Technologies, 28,* 7601-7630. https://doi.org/10.1007/s10639-022-11471-0

Shukri, A. A. M., Che Ahmad, C. N., & Daud, N. (2019). The implementation of a stem literacy module to empower the creative thinking of first grade students. *International Journal of Education, Psychology and Counseling, 4*(32), 219-237. https://doi.org/10.35631/IJEPC.4320021

Sirisuthi, C., & Chantarasombat, C. (2021). Development on the learning module of school-based supervision course for master's degree students, majoring educational administration in Thailand. *International Journal of Higher Education, 10*(4), 21-31. https://doi.org/10.5430/ijhe.v10n4p21

Sjöman, M., Granlund, M., Axelsson, A. K., Almqvist, L., & Danielsson, H. (2021). Social interaction and gender as factors affecting the trajectories of children's engagement and hyperactive behaviour in preschool. *The British Journal of Educational Psychology, 91*(2), 617-637. https://doi.org/10.1111/bjep.12383

Sumarni, S., Putri, R. I. I., & Andika, W. D. (2022). Project based learning (PBL) based lesson study for learning community (LSLC) in kindergarten. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini, 6*(2), 989-996. https://doi.org/1031004/obsesi.v6i2.1637

Suryandari, K. C. (2021). The effect of scientific reading-based project model in empowering creative thinking skills of preservice teacher in elementary school. *European Journal of Educational Research, 10*(3), 1329-1340. https://doi.org/10.12973/eujer.10.3.1329

Tamim, S. R., & Grant, M. M. (2013). Definitions and uses: Case study of educators implementing project-based learning. *Interdisciplinary Journal of Problem-Based Learning, 7*(2), 72-101. https://doi.org/10.7771/1541-5015.1323

Tee T. K., Mohd.Rusly N. S., Sulaiman, N. L., Hanapi, Z., & Sukardi. (2020, November 7). Implementation of project work in design and technology subject for secondary school (Paper ICETVE_047). In *International Conference on Engineering, Technology & Vocational Education* (p. 35). ANP Resources. https://ajvahonline.com/proceeding_book/Buku%20Proceeding_ICETVE2020.pdf

Tomar, K., & Sharma, P. (2022). Blended learning approach for early childhood education. *International Journal of Creative Research Thought, 10*(5), 113-121.

Tripathi, P., Maheswari, K., Malathi, R., Sharma, M., Kaur, N., & Otero-Potosim S. (2023). Challenges, impacts and the importance of digital technologies on modern education in 21st century. *European Chemical Bulletin, 12*(Special Issue 4), 17282-17293. https://doi.org/10.48047/ecb/2023.12.si4.1539

Ucar, S. (2015). The use of technology in teaching science to young children. In K.-C. Trundle & M. Saçkes (Eds.), *Research in early childhood science education* (pp. 167-184). Springer. https://doi.org/10.1007/978-94-017-9505-0_8

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Yeop, M. A., & Gapor, A. L. (2012). The effect of a technology-based project-based learning approach on student achievement and acceptance. *Jurnal Bitara, 5, 31-45.*

Yusoff, M. S. B. (2019). ABC of content validation and content validity index calculation. *Education in Medicine Journal, 11,* 49-54. https://doi.org/10.21315/eimj2019.11.2.6

Yustina, Y., Syafii, W., & Vebrianto, R. (2020). The effects of blended learning and project-based learning on pre-service biology teacher creative thinking through online learning in the Covid-19 pandemic. *Indonesian Journal of Science Education, 9*(3), 408-420. https://doi.org/10.15294/jpii.v9i3.24706

Zahner, P. (1998). *Integration of technology into science education integration of technology into science education* [Master's research paper, University of Northern Iowa]. https://scholarworks.uni.edu/grp/1832