INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES
Vol 14, Issue 11, (2024) E-ISSN: 2222-6990

The Impact of Project-Based Learning-Technology-Based Learning (PBL-TBL) Approach on the Development of Preschool Children: The Perspectives of Educators

[1]Azam Ghazali, [2]Zakiah Mohamad Ashari, [3]Joanne Hardman, [4]Wanbayuree Kaweng, [5]Mohd Noor Idris, [6]Farah Adiba Kamaruddin, & [7]Maizatul Akhmar Mat Yusoff

[1,2]School of Education, Faculty of Social Sciences and Huminites, Universiti Teknologi Malaysia, Malaysia, [3]School of Education, Faculty of Humanities, University of Cape Town, South Africa, [4]Department of Early Childhood Education, Faculty of Education, Fatoni University, [5]Department of Psychology & Counselling, Universiti Pendidikan Sultan Idris, [6]Faculty of Education and General Studies, University College of Yayasan Pahang, Malaysia, [1,7]Faculty of Management & Information Technology, Kolej Islam Antarabangsa Sultan Ismail Petra, Malaysia

Corresponding Author Email: muhammad.nur.azam@graduate.utm.my

To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v14-i11/23728 DOI:10.6007/IJARBSS/v14-i11/23728

Published Date: 23 November 2024

Abstract

The primary goal of this study is to focus on the perspectives of experienced preschool educators on the effectiveness of implementing Project-based Learning activities integrated with Technology-based Learning (PBL-TBL) in preschools, following the National Preschool Standard Curriculum 2017 (NPSC, 2017). This research aims to determine the applicability of this approach in early science education in preschool, with the goal of enhancing children's development, including their knowledge, social interaction, creative thinking skills, and motivation to learn science topics at an early age. The participants in this primary study were nine Malaysian preschool educators, each with a minimum of five years of experience teaching early science in preschool. This study utilized a qualitative methodology, employing a validated and reliable semi-structured interview instrument consisting of five questions. The data was subsequently analyzed using ATLAS.ti9 software through a theme analysis technique. Despite numerous challenges in enhancing the quality of education through early science activities, educators remain optimistic that the PBL-TBL approach can comprehensively boost children's development. Out of the 17 themes discussed, the primary focus is on the significance of the PBL-TBL approach for children, facilitating their knowledge enhancement through engaging and hands-on learning experiences. Additionally, captivating activities involving two-way communication foster increased participation and engagement

from children in verbal exchanges and tasks. This approach also prioritizes learning through observation to enhance children's creativity and fosters their motivation to explore science as a key motivating factor. The dissemination of novel insights from experienced educators will encourage future researchers to engage in Research and Development (R&D) in the domain of Early Childhood Education (ECE). The current effort aims to provide a wide variety of resources that educators can use to improve the quality of early childhood education, aligning with the principles of 21st-century education and the implementation of the NPSC 2017.
Keywords: Early Science, Preschool, Project-based Learning, Social Interaction, Technology-based Learning

Introduction

Education has undoubtedly grown more accessible, interesting, adaptive, collaborative, and effective as technology advances. Contemporary children employ a variety of software and tools to produce presentations and projects rather than relying on traditional pen and paper (Haleem et al., 2022). More profoundly, numerous nations endeavor to emphasize the significance of technology in their plans and programs for education. Furthermore, they believe that the factor that must be attained to achieve educational quality is the empowerment of the education system through Technology-based Learning (TBL) through the use of technological resources in the classroom. Interestingly, Machmud et al. (2021) revealed that the countries of Southeast Asia (ASEAN) have demonstrated the best development in applying Information and Communication Technology (ICT) in their respective education systems. This is attributed to Singapore being the most advanced country in empowering the use of it, and Thailand and Indonesia are still in developing progress. In contrast to Malaysia, the Ministry of Education (MoE) has launched various initiatives focused on empowering the use of technology in the classroom. A particular pursuit is the ICT Transformation plan, which works as a road map for advancing technology integration into the educational ecosystem. It includes guidelines and suggestions for strengthening technology integration into learning, facilitation sessions, and administration (Subramanian, 2023). Delving deeper into the perception from African countries, technological resources have an immense effect on their communities, and it is recommended that the government undertake action to improve the education system by implementing TBL (Wirajing & Nchofoung, 2023).

In the last three years, technology integration has been envisioned to support the development of 21st-century skills and abilities in the learning and facilitation sessions (Allman et al., 2024). Educators specifically mentioned that using technology in the science classroom helps children improve critical thinking, problem-solving, interaction, teamwork, and computational thinking skills (Ramaila & Molwele, 2022). However, it is even more intriguing when TBL is adapted to the Project-based Learning (PBL) approach in the science classroom, which can help them develop holistically (Pugh et al., 2023; Yılmaz, 2023). Silander et al. (2022), determined that interdisciplinary learning and facilitation processes that incorporate PBL-TBL can improve and diversify learning by supporting learners in making sense of phenomena and shortcomings as well as learning disciplines. This includes science, core knowledge, or ideas fundamental to profound comprehension. Conversely, Sormunen et al. (2023), discovered that PBL-TBL adopted in the classroom can assist children in solving problems associated with science concepts more effectively, deploying their creative thinking ideas. Moreover, the incorporation of technological tools into science projects has the potential to boost children's enthusiasm to learn. At the same time, Ginzburg and Barak (2023), revealed that the effect of significant motivation on enjoyment in science learning is related to open interaction between educators and children. Thus, to ensure that PBL-TBL may provide success for children, educators' involvement as facilitators in encouraging children's social connection is deemed very worthwhile as this situation allows children to learn cooperatively (Rahmawati et al., 2020).

Problem Statement

Early science education should serve as a purposeful and engaging platform for young children to learn about science in the Early Childhood Education (ECE) stage. Nevertheless, numerous previous studies have examined the difficulties schools, educators, and students encounter in producing high-quality early science programs. Typically, multiple variables contribute to learners' lack of interest in science at the school level. One of the main reasons is their overall disinterest in the subject itself, coupled with their limited engagement in comprehensive activities (Jekri & Han, 2020). Thus, attaining the national education policy's goal of involving 60 percent of school students in science and 40 percent in literature is challenging (Idris et al., 2023; Ong et al., 2020). Peculiarly, Daud (2019), has extensively discussed the challenges children encounter in science education, namely the lack of desired progress due to variations in individual skills and cognitive abilities. In addition, Ong et al. (2021) have highlighted the importance of incorporating the 5E elements, engagement, exploration, explanation, elaboration, and evaluation, in project implementation to enhance children's interest in learning science. Accordingly, these elements serve as guidelines for creating more meaningful learning experiences.

Science standards and curricula worldwide emphasize the significance of learning by undertaking physical experiments in the science classroom and seek to systematically foster knowledge and skills necessary for learners to understand and perform experiments (e.g., DfES & QCA, 2004; KMK, 2005; NRC, 2012, 2013). However, when considering the challenges of implementing early science education from the perspective of knowledge acquisition, Roche et al. (2020), elaborated that while the objective of citizen science is to facilitate scientific advancement, and the objective of education is to foster learning, these two goals may not always coincide. More profoundly, Anderman et al. (2012), discovered that one of the reasons why learners' knowledge is currently at a low level is that they are only looking for answers on Google and not using their critical thinking skills. According to Alexander's Model of Domain Learning (Alexander et al., 1995), learners must reach the proficiency stage of knowledge development before they possess enough knowledge to engage in critical reasoning. Furthermore, as previously discussed, it is essential to instruct children on properly conveying factual information through both written and oral means. Consequently, this endeavor could promote children's evidence-based thinking (Hoisington, 2024).

Moving ahead, the difficulties of generating comprehensive science education include developing a strong knowledge of scientific principles and creating a holistic learning environment through educator-child and child-peer interaction. According to Oyelekan and Upahi (2023), children cannot engage in educator-led science learning since the educator does not utilize the appropriate language. In the context of their studies, the educator's use of language other than the children's native language will make it challenging for them to grasp the topics conveyed. Conversely, through an initiative-response analysis between children's learning and educator's explanation, the findings demonstrated that a strong dominance of educators in the dialogue makes it difficult for children to grasp scientific ideas in the activities conducted (Munkebye & Staberg, 2023). Furthermore, Disney and Geng (2021), discovered that, in TBL activities, children allowed to use electronic devices while learning will exhibit intolerance toward their peers and choose to remain solely engaged with the game they are playing. As a result, several previous researches imply that material-centered learning, such as the use of technology, requires educator guidance (Umugiraneza et al., 2018; Zhang, 2022).

More recently, researchers have suggested that the science curriculum can enhance creative thinking (Barrow, 2010; De Haan, 2011). However, there is limited research on whether creative thinking can predict scientific reasoning (Willemsen et al., 2023). The following happens due to a wide range of circumstances, including educators' inability to devote time to activities that allow children to express their creative ideas, such as doing experiments in groups, due to time restrictions (Phang et al., 2023). Moreover, discussing further the challenges of empowering children's creative thinking while conducting science activities in the classroom, Kaya and Kaya (2022), discovered that children who use traditional learning methods have a lower attitude toward science. This includes showcasing their creative ideas as opposed to children who use more integrated learning, such as integrating intelligence theory in learning. On the other side, Hodges et al. (2020), discovered that children who were allowed to learn science tasks utilizing the TBL technique demonstrated higher levels of creativity than children who were not exposed to technology.

Next, in terms of children's passion for learning science in class, summative evaluations have proven that it will cause children to generally lack motivation and have low self-confidence in learning (Harlen, 2005). The self-esteem of underperforming students is specifically impacted, diminishing their motivation to exert effort in their education and widening the disparity between high-achieving and low-achieving students (Kapten & Timurlenk, 2012). This condition emerges due to the presence of learners who lack motivation and hence remain passive participants in the learning environment, resulting in their failure to benefit from their involvement. Furthermore, the lack of learners' engagement with the current tactics highlights the necessity for a more all-encompassing solution (Rone et al., 2023). Research believes that one effective method to enhance the caliber of children's educational experience in science class is to offer them praise judiciously. Therefore, praising learners who are actively engaged in an activity with accolades like "Wow, that is impressive" or "brilliant" may unintentionally imply to other learners who are not participating that the given response is so remarkable that it cannot be surpassed or surpassed (Tanner, 2013). Hence, it is necessary for educators to praise children equally with the aim that those who are less driven to study science will become more motivated.

Therefore, through the challenges and gaps that have been addressed above, four objectives will be discussed, namely:

1. Explore the educators' perspective of PBL-TBL activities in preschool that need to be implemented to increase children's knowledge of science.
2. Explore the educators' perspective of PBL-TBL activities in preschool that need to be implemented to improve children's social interaction development.
3. Explore the educators' perspective about PBL-TBL activities in preschool that need to be implemented to boost children's creative thinking skills.
4. Explore the educators' perspective of PBL-TBL activities in preschool that need to be implemented to help children be motivated to learn science.

Literature Review

PBL-TBL Approach in Early Science Education

Recently, educators have been more inclined to incorporate PBL into science classroom because of its positive impact on children's holistic development. (Nurhidayah et al., 2021). Interestingly, Guo et al. (2020), discovered that individuals who acquire scientific knowledge can enhance their academic performance by direct project engagement. This study is supported by the findings of Santyasa et al. (2020), who highlighted that physical projects enhance children's confidence in learning and motivate them to get greater academic results in their present pursuits. Similarly, the study conducted by Samsudin et al. (2020), revealed that educators who are able to implement projects-based activities for children can help them analyze a problem systematically, aiding in their understanding of the issue. In addition, the study conducted by Muchsin and Mariati (2020), revealed that when learners are provided with the chance to engage in hands-on projects related to science, they demonstrate enhanced creative thinking abilities.

In addition, moving on to empowering the use of technology in the education system, by utilizing technological resources in the classroom, educators and children can acquire new information, abilities, and experiences (Demir & Akpinar, 2018). Furthermore, exposing children to TBL activities will help them learn about concepts 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 technology has gained traction (Ilomäki & Lakkala, 2018). As a result, the usage or incorporation of technology in schools, such as the use of digital tools during teaching and facilitating sessions, assists educators and students in strengthening their knowledge through 21st-century thinking. This can be demonstrated, as mentioned by Weintrop et al. (2016), that the integration of technology in the classroom can assist children in exploring abstraction (the use of technology in communication and data visualization), analysis (the use of technology to categorize data), automation (the use of technology for understanding human anatomy), and modeling (the use of technology to discover human anatomy through 3D applications).

As an overview regarding the use of PBL-TBL in the classroom, it identifies that the elements of this integration of these two approaches are a new paradigm in 21st-century education where it promotes children to gain knowledge directly through active, interesting, cheerful, and proactive learning at school (Rohman et al., 2019). It also assists educators in mastering technological pedagogical content knowledge as it is recommended in the era of the

Industrial Revolution 4.0 (Elviana et al., 2022). According to Almulla (2020), adopting the PBL approach in learning and facilitation sessions promotes children's participation by facilitating knowledge, information sharing, and discussion. As a result, the PBL approach is highly recommended for educational applications in classrooms and should be advocated at various levels of education, including ECE centers. In ECE settings, the empowerment of PBL through TBL significantly boosts children's holistic development. According to Ortega-Sánchez and Jiménez-Eguizábal (2019), the PBL approach with ICT makes it easier for students to acquire technological capabilities. This is connected to the growth of their social and communication competencies and their ability to work cooperatively and collaboratively. However, to ensure that these developments can occur through the correct process, the educator's role as a guide is crucial in motivating children to complete activities well. Moreover, the most critical element influencing the success of technology integration in PBL is the educator's capacity to assist in learning (Rahmawati et al., 2020).

Theoretical Framework

When implementing PBL-TBL activities, an educator needs to first recognize what aspects are required in both approaches. Identifying the resources that can be used in class is critical for educators to increase active class engagement. From a pedagogical standpoint, prior research has substantiated the adoption of the PBL approach in science classrooms. Markula and Aksela (2020) demonstrated that this approach facilitates individual learning and enables educators to focus on various aspects of PBL. Furthermore, PBL has been discovered to enhance academic performance in science education, with a particularly pronounced impact in the social sciences compared to individual science or STEM activities (Chen & Yang, 2019). Hence, implementing PBL in preschool settings significantly fosters a more profound and purposeful educational atmosphere for young children (Ferrero et al., 2021).

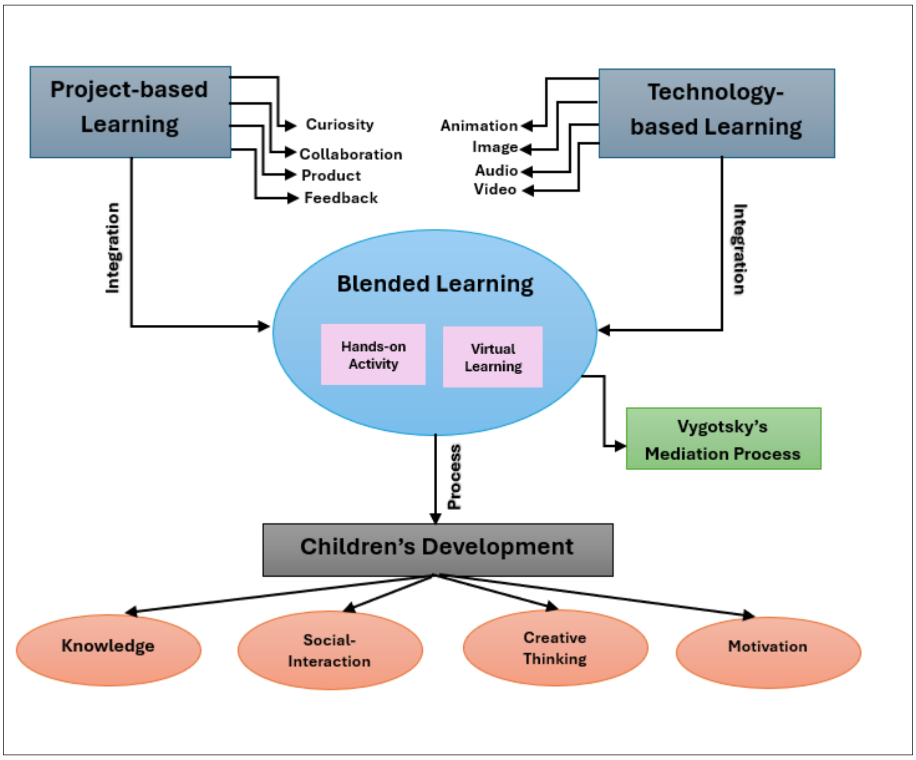

Figure 1 The Implementation of PBL-TBL Approach in Preschool Classrooms

In order to emphasize the components of 21st-century learning in educational institutions, educators are advised to incorporate PBL-TBL in the class activities. This approach not only encourages children to engage with one another but also allows them to enhance their creativity and achieve greater success in their educational pursuits (Rahmawati et al., 2020). One of the best ways how to integrate the TBL into the PBL approach is by introducing multimedia elements. Notably, incorporating these elements in educational settings can enhance children's participation, facilitate comprehension, and enhance the enjoyment of learning. In the classroom, educators can utilize several media types to improve the learning process, including audio, video, photos, animations, and interactive information (Evelyn, 2024). This is due to the fact that multimedia technology facilitates the simplification of abstract knowledge, accommodates individual variances, and enables the coordination of multiple representations from different perspectives (Abdulrahman, 2020). Consequently, the outcome of this integration will be the implementation of Blended Learning (BL). BL is a teaching approach that combines both Face-to-Face (F2F) and online settings to enhance learning engagement and provide flexible learning experiences. Moreover, it goes beyond using a basic online material repository to support in-person classes, incorporating rich settings for a more comprehensive learning experience (Hrastinski, 2019).

In order to ensure that these BL activities run effectively, educators must fulfill their genuine mediation roles throughout the learning and facilitation process. Interestingly, Vygotsky proposed the concept of mediation, which refers to the idea that when humans encounter an object in their environment, they do not interact with it directly but through several tools. According to Russell (2002), these tools can be defined as facilitating interaction between individuals and objects. On the other hand, considering the Vygotskian perspective (1978), knowledge is improved and made viable through social mediation, resulting in increased coherence. More profoundly, mediation is how exterior socio-cultural phenomena are converted into interior mental processes. While Vygotsky generally defines tools as psychological and symbolic in a mediation process, practitioners of the Neo-Vygotskian movement also acknowledge the role of physical objects and the environment in facilitating learning. These examples encompass the utilization of equipment that aids in comprehending intricate science concepts or computer software in the field of ICT (Davis & Miyake, 2004; Puntambekar & Hubscher, 2005; Wertsch, 1991; Wertsch et al., 1984).

In the present study, educators should employ the appropriate mediation method to ensure that each child's knowledge in science, social interaction, creativity, and science can be improved smoothly. Understanding their roles in neutrality is one of the most effective ways educators can serve as mediators. In addition, establishing a trustworthy connection necessary for dispute resolution becomes unattainable if a mediator displays bias towards a single person. Moreover, the mediator's role is to oversee the mediation process, not to conserve, recuperate, or constitute a decision (Domenici & Littlejohn, 2000). Notably, an effective mediator will help everyone involved by finding common ground, while the mediator is perceived as a catalyst or an educator who assists in motivating and propelling the process (Stulberg & Love, 2009).

Research Significance

Preliminary research is crucial in establishing a foundational knowledge (de Abreu,2023) base on PBL-TBL. This research not only deepens understanding of the topic but also provides a framework for future studies to explore more specific and relevant aspects. Firstly, it supplies the necessary theoretical background by offering a thorough overview of basic concepts, historical context, and implementation strategies of PBL-TBL. This foundational knowledge aids future researchers in grasping the fundamental framework of the topic before commencing their investigations. With a comprehensive theoretical reference, researchers can pinpoint particular areas that have yet to be extensively studied, thereby guiding the direction of subsequent research.

Moreover, this preliminary research serves to identify knowledge gaps within this field (Widyasari et al., 2019). Early investigations often encompass key issues, challenges, and the potential efficacy of Project-Based PBL-TBL across various educational contexts. This information assists future researchers in focusing on underexplored issues, such as the effectiveness of this approach in rural areas, its suitability for specific student groups, or its long-term impact on students' skill development. Additionally, this preliminary research offers future researchers the opportunity to compare and evaluate the methods used in previous studies. Through critical analysis of the methodological approaches in early research, future researchers can select more suitable methods or develop new strategies to enhance the quality and robustness of their studies.

In summary, preliminary research on the topic of PBL-TBL is a crucial foundation for continuing knowledge development in this field. It not only aids future researchers in producing higher quality and more relevant studies but also contributes to more effective and holistic educational reforms. With the important data highlighted in this study, it provides a clearer picture for designing more comprehensive activities in early science education while offering guidelines for educator and leaners (Abu Bakar et al., 2021) to carry out high-quality activities aligned with 21st-century education standards.

Methodology

Research Design

This study employs a qualitative methodology in the form of a case study. The selection of this design is grounded on the examination conducted by Clarke and Creswell (2015), which asserts that this approach features the capability to perceive difference experiences from many perspectives. Hence, a preliminary study was implemented to examine the "needs" associated with the impact of PBL-TBL activities on science learning in Malaysian preschools. Preliminary studies are frequently carried out to enhance the intervention and assess its acceptability, practicality, cost, and uptake (Smith et al., 2015). As a result, the findings from this study will serve as a foundation for future researchers to develop suitable learning modules for early science education. Moreover, to identify the needs mentioned earlier, the researchers utilised a standardised series of interview questions to gather the perspectives of nine experienced preschool educators from various regions in Malaysia. Moreover, this study was carried out electronically, with all participants leveraging the Google Meets platform. Upon obtaining a response from each participant, they opted to perform an online interview due to its convenience in facilitating their participation in this study. Janghorban et al. (2014), contended that online platforms offer more convenient circumstances for participation in the new era of research. This study spanned nine weeks, from the beginning of July 2023 until the beginning of September 2023.

Study Participants

Researchers utilized two alternative sampling techniques that consist of purposive and snowballing sampling. Purposive sampling is a process in which a group of study participants with certain characteristics are selected based on the researcher's knowledge and the specific aim of the research (Robinson, 2014). Hence, researchers utilized this technique to recruit eight participants (P1-P8) (see Table 1) based on criteria such as their ECE experience, science teaching skills, and ability to be facilitators. In contrast, snowball sampling involves the researcher personally selecting specific samples based on the qualities identified by the study participants who were already recruited (Parker et al., 2019). P8 referred P9 as a potential participant who meets the criteria set by the researchers. In summary, this study includes 9 preschool teachers that have years of experience. The experience qualification is substantiated by their background in teaching early science in preschool for a minimum of 5 years. Mulyaningsih and Arifin (2021) contend that teachers meeting the criteria of "experienced" possess a minimum of 5 years of teaching experience.

Table 1
Participants' Background and Samplings Techniques

Participant	Sampling	Teaching Experience	Location
1	Purposive	5 years	Public Preschool
2		14 years	Public preschool
3		14 years	GLC-based preschool
4		11 years	Public preschool
5		17 years	Private preschool
6		5 years	Public preschool
7		5 years	GLC-based preschool
8		5 years	Public Preschool
9	Snowball [Recommended by P8]	6 years	Public preschool

Instrument

This study used a single instrument: Preschool Educators' Perceptions of Early Childhood Science Activities Using the PBL-TBL Approach (PrePercept-PBL-TBL). This is a semi-structured interview instrument developed independently by the researchers. An exploratory interview is referred to as a semi-structured interview by Magaldi and Berler (2020).

Table 2
Constructs and Items Consist in the PrePercept-PBL-TBL Instrument

No.	Construct	Item
1	Issues in teaching early science	1
2	Integrating National Preschool Curriculum Standard 2017(NPCS 2017) with PBL-TBL Activities	1
3	The best approach could be utilised to teach early science	1
4	The importance of PBL-TBL approach for children to gain knowledge through science concepts	1
5	The importance of PBL-TBL approach for children's social interaction development	1
6	The importance of PBL-TBL approach for children's creative thinking	1
7	The importance of PBL-TBL approach for children's motivation in learning science	1

The researchers further elaborated that the semi-structured interview is normally cantered on the major subject that offers an overview and is typically based on an indication. Researchers have considered the shortcomings in earlier research in order to initiate developing the constructs and items of this instrument. Furthermore, although the researchers independently developed the constructs and items, this instrument was reviewed and then validated by two ECE experts, and ultimately, Cohen's Kappa Coefficient analysis revealed a realism value of (k = 1). That implies that the two validators have strongly agreed upon every construct and item of the instrument. Table 2 indicates the following constructs and items of this instrument.

Data Collection
Prior to the data collection process, researchers submitted a letter to Universiti Teknologi Malaysia requesting permission to conduct the exploratory study. Researchers also adhered to the guidelines set forth by the university by referring to the research circular issued by the UTM Research Management Center (RMC). Consequently, each study participant received an e-mail with a consent form attached. After receiving each participant's voluntary consent and background information, researchers assisted the data-collecting process virtually using the Google Meet platform. After the interview session was introduced, each participant was given 30-40 minutes to answer all the questions. Following the interview, each study participant received a transcript to confirm their responses and perceptions. All collected data was kept confidential and used strictly for research purposes.

Data Analysis
In order to facilitate accurate analysis of the gathered data, researchers employ the thematic data analysis approach, leveraging the ATLAS.ti 9 software. The methodology outlined is a way to analyze qualitative data (Kigor & Varpio, 2020). Usually, it is utilized to examine a set of texts, such as a record of an interview. The researchers thoroughly examine the data to identify prevailing themes - subjects, concepts, and patterns of importance that occur regularly. A total of nine transcripts were utilized to conduct this theme analysis. The researchers adhered to the guidelines established by the ATLAS.ti 9 software in their approach (Soratto et al., 2020). First and foremost, it is crucial for the researcher to create a

project. Subsequently, the researchers named this project "Educators' Perception towards PBL-TBL." After that, six steps need to be followed by the researchers as follows:

1. Adding document. Researchers uploaded all nine transcripts from nine interview sessions with all study participants.
2. Identifying relevant data segments. To ensure these segments are discovered, the researcher conducted a scanning and skimming process for all transcripts.
3. Coding, writing, memos, and comments. The researchers highlighted meaningful sentences and answered research questions for each transcript, which were coded into new themes or the same themes.
4. Analyzing and querying data. Once the themes have been well recorded, they will be analyzed based on each research question using the automatic visualization facilities provided.
5. Generating reports. After the visualizations had been downloaded based on the research questions, the researchers downloaded the final reports for this analysis.

Findings

The researcher employed the thematic method to analyze the data and thereafter documented all the findings in this study. The data analysis procedure yielded 17 overarching themes concerning the significance of PBL-TBL for preschoolers based on the perceptions of nine participants (P1-P9). To ensure that the study findings are recorded more systematically, the researchers have separated into four variables to answer the research questions independently. However, before the researchers address the four primary study questions, three additional constructs will be discussed to better understand the needs of the PBL-TBL approach in science education in preschool settings.

Construct 1: Issues in Teaching Early Science

There are seven themes (see Figure 2) that emerged from the issues mentioned by the participants and were successfully recorded through the analysis undertaken. The most disputed issue among all themes is (I1) Lack of Materials, which four participants elaborated on. The participants believed they could not conduct quality early science activities due to a lack of science resources, materials, and equipment. This can be demonstrated by observing the conversations below:

> *"Another thing happened in my classroom is,,, let's say that if I planned to teach about balloon bursting, it's really problematic when it comes to finding suitable and appropriate materials. This has happened to me frequently because I'm living in a remote area, and it's too far if I want to get out from here to get the stuff that I'm looking for."* – P1
> *"Urmmmm, the materials related to science education that we provide in the classroom are limited, and this situation forces children to prepare the materials with us to ensure an activity like botanical science could be implemented. Just my two cents."* – P3
> *"You know what,,, urmm, it's hard for me to find any appropriate science resources. This situation stresses most of us from the preschool section who are choosing the teaching strategy by just using paper-based modules. They do not use the material. That is the problem I see. That's all."* – P4

"The main problem is in terms of preparing materials and teaching aids. If we want to do an investigation, we're probably using materials that are not provided in the classroom. I guess it's hard for us to find it." – P8

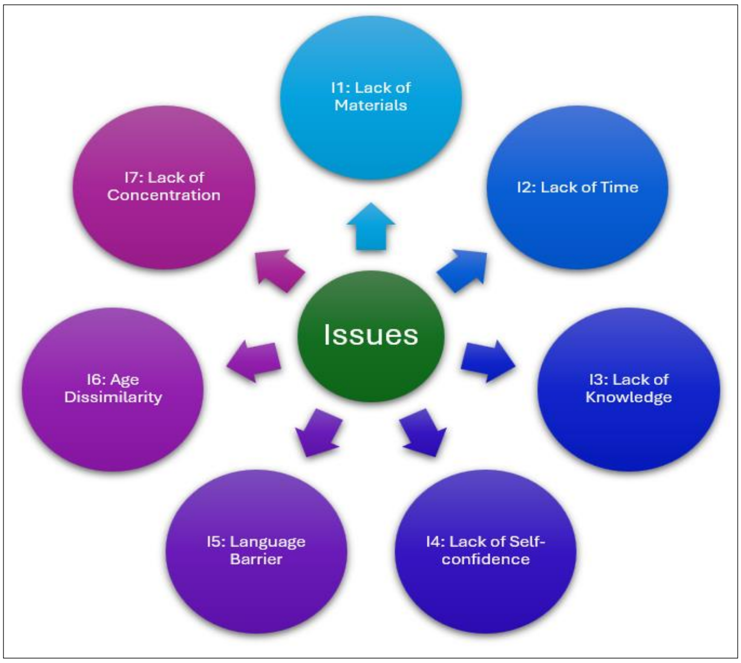

Figure 2 Theme Pertaining the Issues in Teaching Science Education for Preschoolers

In addition, the study participants also believed that (I2) Lack of Time provided to teach the topics related to early science has also made it difficult for P3 and P8, particularly, to provide meaningful learning. Furthermore, the (I3) Lack of Knowledge about science topics and concepts also causes P1 and P7 to lack ideas to vary their teaching. Other than that, the (I4) Lack of Confidence also forced P4 to be less passionate about generating an active learning atmosphere in scientific classrooms. Next, the (I5) Language Barrier, which is the official language used by P2 in science activities, also makes it harder for children to grasp more clearly since they use their dialect in their daily communication. Moreover, the (I6) Age Dissimilarity is also a factor in P6's difficulties in selecting themes suited for all youngsters. Finally, the (I7) Lack of Concentration displayed by children makes it impossible for P5 and P9 to construct comprehensive science learning.

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

Only two themes were successfully recorded in the analysis to explore each study participant's perspectives on this construct: (A1) Relevant Unconditionally and (A2) Relevant Conditionally. This signifies that all participants agree that PBL-TBL activities are included in the content of NPCS 2017, except for a number of them who agree conditionally. Table 3 indicates the perception of agreement as follows:

Table 3
The Agreeableness of Participants Pertaining to PBL-TBL Approach in Preschool Settings

t	P1	P2	P3	P4	P5	P6	P7	P8	P9
(A1) Agree Unconditionally	/	/	/		/		/	/	/
(A2) Agree Conditionally				/		/			

Although all participants acknowledged their agreeableness towards the utilization of the PBL-TBL approach, P4 and P6 highlighted the reasons why the PBL-TBL approach can be applied. However, they also considered other factors, such as the approach's needs in terms of time and children's development. It can be demonstrated in the following conversations:

> *"Ok, let's be honest. I guess this approach could be applied, but it depends on the situation. Like me, myself, in terms of implementing the project itself, it will take some time. We need to take the right time."* – P4
> *"In my honest opinion, sometimes it is relevant to be implemented, and sometimes it is not relevant to be implemented. According to my main key point of view, the children's level is different. Perhaps this NPCS 2017 can be carried out directly in the urban preschools."* – P6

Despite these two participants expressing slightly different perspectives, the other participants unanimously agreed that this strategy should be used directly in early science activities at preschool. This can be demonstrated using the evidence presented by P8 as follows:

> *"For me, it is approachable because the project and technological approaches itself have been emphasized in NPCS 2017 itself. Why? The hands-on approach to this project can stimulate children's high-level thinking."* – P8

Construct 3: The Best Approach Could Be Utilized to Teach Early Science
In order to explore the perception of each study participant regarding the most appropriate approach that can be deployed for science education at the preschool level, the researchers have successfully designed five essential themes as follows:

Table 4
The Best Approaches in Implementing PBL-TBL Activities

ıt	P1	P2	P3	P4	P5	P6	P7	P8	P9
(T1) Project-based Approach					/		/	/	/
(T2) Inquiry Approach	/							/	/
(T3) Learn through Play Approach		/				/			
(T4) Integrated Approach			/						
(T5) Thematic Approach				/					

The highest theme successfully recorded was (T1) PBL, with four out of nine participants agreeing that this approach is ideal for implementing early science activities in preschool. To clarify, their responses were recorded as follows:

> *"Usually, if I want to implement a project, I use existing or called real materials. For example, if I plan to do an experimental activity such as the world of materials, the selection of those materials must be interesting. We must provide them with interesting material, and also, our voice must be quite clear when doing the activity with them."* – P5
>
> *"In NCDRC [National Child Development Research Centre] this year, we have not followed and focused on the rigid timetable, but we are using a project approach entirely. So, when using the full project approach, there should be an investigation. So, this time, we encourage children to do an investigation using a project approach."* – P8
>
> *"Example of implementing the project, the simplest for preschool children is to plant the seeds. Right? The process is the easiest; materials are easily available, and they can see progress day by day. The peanut seeds germinated."* – P9

RO1: Construct 4: The Importance Of PBL-TBL Approach for Children to Gain Knowledge Through Science Concepts

For the knowledge acquisition of children when they join any PBL-TBL activities, two themes were successfully recorded and analyzed by the researchers, namely the Theme (T1) Increment of Knowledge and (T2) Reinforcement of Knowledge. Explaining (T1), most study participants viewed that learning using this approach can help children improve their knowledge to understand any concepts regarding early science education. This can be observed through evidence from the following statements:

> *"Even if we do hands-on activities and afterward, with the help of the animation provided by technological tools, it can increase the knowledge of children. For example, if we only do hands-on, they are quite blurred. But, with the explanation of animation, it will improve their knowledge. Children love things that move. If I show them an animated video, then they will remember what was shown. They will retell it."* – P1

"They will understand better about the particular topic because we display the learning on a projector." – P2
"For example, children who often pay attention to activities involving technology, they always enjoy learning. And when they enjoy learning, it can improve and deepen their knowledge." – P6

Additionally, there are two successful codes listed in Theme 2 (T2). Two out of nine study participants thought that learning through PBL-TBL can strengthen the knowledge or information already known by children. This can be proven through the following statements:

"In terms of knowledge, sometimes they do know more than their educator does because they have seen it on the internet. We will do it at school. Sometimes, he knows from us. If there is an experiment, they will do it. Sometimes, they are clever and advanced." – P5
"But in my opinion, these PBL-TBL activities urmmm, if children can access it, it can help them to know certain concepts to some extent." – P9

Examining the two themes, study participants predominantly agreed that learning aids such as technological tools integrated with PBL activities can improve children's ability to know information and learn more readily. As a result, exposing children to digital learning is appropriate in preschools. They can learn something new and strengthen their previous knowledge based on what they see and learn.

RO2: Construct 5: The Importance Of the PBL-TBL Approach for Children's Social Interaction Development
Researchers effectively recorded four themes to demonstrate the importance of PBL-TBL activities to children. The first theme is Two-Way Communication (T3). Participants in the study felt that this activity could increase two-way communication between child-peers or child-educators. The following statements demonstrate this proof as follows:

"For example, showing animals, these animals are like baby kangaroos. They will ask why the baby kangaroo is in the pocket. So, they will ask about things that cannot be seen." – P7
"For example, sometimes there is noise, they will tell you, "Educator, you have to mute." Although the class is done online, the class can be controlled when compared to a face-to-face class." – P8
"But it can help social interaction because they talk and discuss with each other. What will happen after this? Hey guys, look at this. Huh. The interaction will happen. Because children like to see movement, colorful things in front of their eyes." – P9

Furthermore, the second theme properly documented was (T4) Joy in Learning. PBL-PBL activities can improve children's interaction while also making learning more enjoyable. When children have joy during the learning sessions, their engagement with peers and educators also improves. There are three codes that demonstrate evidence of this explanation, as indicated by the statements as follows:

"They will show fun emotions to enjoy the activity because we use technological materials in the class." – P2

"Their association is still able to socialize well because they are still able to participate in the activities thoroughly and have fun in the class." – P3
Ok, for example, there are children who prefer e-modules. And when a child is good at digital access, and when he does and can do it, he will feel happy. – P9

Additionally, two other themes that have been successfully analyzed as to why PBL-TBL activities are vital to the early learning process of children are (T5) Many-Way Communications and (T6) Increment in Socialization. There is only one code for both themes, which can be observed in the following statements:

"Meaning that they can interact with friends randomly and can tell what is being done. It means they can socialize with friends; they will communicate together." – P5
"When self-motivation increases, they tend to socialize with friends and class; that's their social interaction." – P6

RO3: Construct 6: The Importance of PBL-TBL Approach for Children's Creative Thinking
For the variable of children's creativity, five themes were successfully recorded and analyzed by the researchers. The first theme is (T7) Learning By Observation. In this theme, the researchers discovered that most of the study participants thought that children actually demonstrate their own creativity if they observe the people and objects around them. This can be proven through the following statements:

"Actually, nowadays, we want children to reason critically. Children's imitation is very good. At this stage of early childhood education, we do teach children to imitate. A famous theory in early childhood education indicates that when children imitate, their neurons will be connected. And they will apply on what they see." – P3
"Ok, actually, in terms of creativity, that's why we need to have a guide next to children for the integration of technology in PBL activities. This means that for preschool children, parents need to be by their side to help them control the tools. For the creativity part, I mean, for materials that need to be used in learning sessions, we need to tell parents first. So, when they get encouragement and guidance from parents and educators, even if the activities are carried out physically or online, there is no problem with making them more creative because they observe what adults did." – P8
"When they look at the illustration that I show to them virtually, so I let them do the project in the group. Based on what they see, they can build up their creativity based on their understanding of the contents shown in the video." – P9

In addition, through the interviews conducted, there is a second theme that was successfully formulated by the researcher, which is (T8) Stimulate Thinking. To explain more clearly, researchers believe that the use of digital technology in learning can stimulate children's thoughts and ideas to become more creative. This can be proven through their views as below:

"With the help of teaching materials such as videos or digital objects, all of them can stimulate children's thinking in the classroom as well as at home." – P3
"The thinking skills we get, where the children themselves will respond to the questions we ask online." – P8

In addition to that, there are three other themes that support the importance of creative elements to children's learning through PBL-TBL activities. The following themes are the (T9) Development of Fine Motor Skills, (T10) Generating Varieties of Ideas, and (T11) Making One's Own Decision. To prove more clearly the views of the study participants, the researchers listed each of the codes from T9, T10, and T11, respectively, consequently as in the statements below:

> *"There was one person who knew about technology. They would say, "Educator, please press this," then one of his friends replied, "No, it is not that way," so they did it themselves, and I just saw and assumed that they were good at using the technology."* – P1

> *"When they socialize, they will automatically share various ideas."* – P6
> *"For example, they can control the mouse, isn't it right? And when they click, flowers or stars will appear, and there will be applause (congrats). So, from this situation, not only can they create visuals, but they can also make their own decision to choose whatever answers on the technological tool that they are using."* – P7

RO4: Construct 7: The Importance Of PBL-TBL Approach for Children's Motivation in Learning Science
To explain more about the importance of PBL activities to motivation variables, the study participants shared their views on the motivation gained from learning particular topics through digital learning materials. Five themes were successfully recorded and analyzed, and the first theme was (T12) Eager to Learn. There are five codes that were successfully recorded, and the study participants think that learning through PBL-TBL activities can increase children's enthusiasm for learning. This can be observed through evidence such as the statements below:

> *"They are very excited. As I display, for example, if there is an e-module, they will make it themselves. They can press themselves. Like myself, I will display the LCD and build learning, and they are excited (wow). If I pause, pause, pause, they show an extraordinary feeling of excitement*– P1
> *"They will be more interested, and possibly the next day, they will ask me to do the activity again. Because it is different from the others."* – P2
> *"Yes, they will be more enthusiastic and interested."* – P5
> *"From here, when they have knowledge, automatically, it can increase self-motivation* – P6

In addition, the second theme that was successfully analyzed based on interviews is the (T13) Initiative to Do More. Several of the participants thought that the use of technological tools in science classes would give children the initiative to perform the task again and again. This means that children will be more enthusiastic about participating in an activity. This can be proven through the following evidence:

> *"When there is a child who is an expert about something, when we say "Oh, he's clever," the sense of self-confidence and self-motivation is higher."* – P7

"When it comes to motivation, we give them applause or praise. Normally, in the classroom itself, it is very motivating when they complete the task, we praise them, and they turn on to show their happiness to their friends. Even for me, this situation gives high enthusiasm and motivation for the children themselves." – P8
"We show, urmm, show the video using the projector or video on television. Even though we don't have a specific app, they are still excited. Why? They see and explore new things in science." – P9

Subsequently, four other themes were successfully documented, each having one code. The third theme is (T14) Attract Attention to Learn, followed by theme (T15) Internet Influence in Learning, followed by theme (T16) Help Children to Understand Easier, and last but not least, it is followed by theme (T17) Efficient Guidelines. Although only one participant spoke about each theme, it was imperative for the researchers to obtain a more open perspective on the role of motivational aspects in influencing children's motivation in learning. To clarify each theme's code in further detail, look at the statement below, which is grouped according to themes T14 – T17 consecutively.

"In terms of motivation, the use of technology in PBL is seriously great because we can attract their attention by knowing the technology that they are using." – P4
"They are still interested because the current generation considers the internet as the number one. They even have internet at home." – P5
"Now we really have to use it because technology can make it easier for educators to tell children about something related to early science." – P5
"It is very motivating for children because there are many good things compared to bad things about the use of technology. Because we, as educators, observe the movements and actions of children in class." – P3

Discussion
The data indicated four significant findings. To begin with, PBL-TBL activities are essential for children because they can boost their cognitive development by engaging them in tasks that increase and strengthen their knowledge at a young age. A significant proportion of the participants believe incorporating technology into project activities can enhance children's comprehension of the topics they have learned (Ramadhan, 2021; Yeop & Gapor, 2012). In addition, Rohman et al. (2019), believed that when children are provided with the flexibility to explore scientific concepts through project activities, they may grasp that knowledge more clearly and critically. Other than that, this is corroborated by Chanlin's (2008) study, which discovered that during the PBL-TBL learning implementation, children's learning outcomes were evaluated based on their accomplishments in terms of skill development. It also includes the ability to synthesize and elaborate knowledge, participate in scientific exploratory tasks, and use technology to support and report on their research work. The study conducted by Sithu (2021), supported the notion that the efficient and successful implementation of PBL-TBL results in enhanced comprehension and understanding of various subjects among children. Moreover, Shpeizer (2020), recommended that one effective method to boost children's knowledge is utilizing the educational resources provided by Google Tools. This can be achieved through engaging them in project-based activities that promote active and meaningful learning experiences.

Moving on, many participants believed that PBL-TBL activities can help children build social skills through collaborative interaction. Interestingly, Peterson et al. (2016) discovered that children could express their feelings and thoughts (personal function), tell stories (imagination function), and explain things like the project they are working on (information-giving function). To assert this notion, Kılıç and Ulu (2021), revealed that engaging in activities that comprise practical applications, such as implementing projects, can enhance children's soft skills, including their ability to collaborate with peers and communicate effectively. Furthermore, Nathaniela and Esfandiari (2023), discovered that by incorporating technology into education, children can work with educators and peers to finish projects successfully. As a note for educators, increasing PBL-TBL activities positively affect the classroom environment and the development of children's communication since they are brave enough to explain the project results to their friends. Furthermore, it will also promote composing skills and improve children's language fluency (Machado, 2016). From this explanation, educators can vary communication in the classroom. At the same time, the educator can relate the concerns mentioned with the children's prior experience or knowledge while interacting with them. In this way, it can increase their ability to share ideas through direct conversation in the classroom.

Following that, researchers describe how the study participants' perspectives on the value of PBL-TBL activities in preschool might boost children's ability to utilize their creative thinking skills. It is commonly known that using digital materials in the classroom can boost a child's focus on learning, and then they can be inspired by the display. Thus, educational videos can be used to their fullest potential by aligning the modality with the topic. Educators can make the learning process more cognitively taxing by delivering new information through visual and auditory channels and allocating specific types of information to the most suitable channels. Moreover, a parallel and complimentary stream of information is presented to the learner to highlight characteristics that should be processed in working memory, such as when an animation of a process is displayed on the screen while it is narrated (Brame, 2016). However, as indicated by child experts, the outcomes of a study by Wilson and Korn (2007) suggested that children's attention diminishes after 10-15 minutes of learning time. Thus, the first and most crucial rule for making educational videos as engaging for children as possible is to make them brief and short (Brame, 2016). Hence, understanding the contents of the learning topics more easily encourages children to do activities in a well-excited way. As a consequence, Rahmawati et al. (2020), discovered that this understanding can help children to participate in the creation of product activities, which exposes them to working collaboratively and sharing ideas openly.

Next, while discussing the relevance of PBL-TBL activities to children from a motivational standpoint, it can be concluded that most participants believed that the approach would drive children to learn and be more motivated when they are exposed to this 21st-century learning. Makaramani (2016), debated that another aspect influencing the success of PBL-TBL activities is the needs and interests. This can be asserted by the findings of Belagra and Draoui (2018), who highlighted that incorporating technology into the PBL approach is expected to boost the desire of learners to learn and grasp science. Another interesting finding to be discussed is that as a motivational resource for children to keep learning in the classroom, technology and instructional resources are crucial aspects of PBL implementation that set it apart from other pedagogies (Krajcik & Blumenfeld, 2006). It is in the view of the fact that technology tools themselves, according to Kokotsaki et al. (2016), are crucial enablers for learners to engage easily with the PBL process. Through the findings of the current study, the participants have revealed that if PBL-TBL activities are carried out more comprehensively, it will help children understand more easily. For example, children's understanding of a problem becomes easier if they are allowed to see the best ways to solve the problem. One of the best ways to do this is to access information online. More profoundly, Affum (2020), and Ghoshal (2023) revealed that individuals who learn a topic using the assistance of the internet can increase their success in their learning. Therefore, it is crucial for educators to establish children's interest in early science activities in preschool. Notably, children in this century should not learn skills from traditional classrooms. They should be provided with applicable abilities corresponding to the demands of the modern global world (Aabla, 2017).

In a nutshell, the continuity between knowledge, social interaction, creativity, and motivation can be established in implementing PBL-TBL activities in preschool. The children's cooperation and the educator's role must work together. In addition, educators play the most crucial role in encouraging children to participate in PBL-TBL activities inside or outside the classroom. Although some problems exist, such as the extended time allotted to complete project activities (Novak & Krajcik, 2020), educators should be more willing to perform these activities at appropriate times and settings.

Conclusion

Implementing this study creates a greater opportunity for future researchers to explore the significance of the PBL-TBL approach used by ECE educators in the context of teaching and facilitation in classrooms. This is attributed to all of the study participants confidently agreeing on the attempts to implement PBL-TBL activities in ECE centers. After all, it allows children to learn in a 21st-century education environment and empowers skills and children's talents to produce projects based on meaningful and active engagement with educator guidance. Nevertheless, the findings of this study will be a steppingstone for the MoE to further improve the quality of education through the application and integration of technology in project-based activities at an earlier stage. Moreover, it will be a good overhaul in preparation for primary school children.

Conflict of Research

All authors declare that they have no conflicts of interest.

–

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 Universiti Teknologi Malaysia under UTM Nexus Scholarship.

References

Aabla, B. (2017). A review on 21st century learning models. *International Interdisciplinary Journal of Education, 6,* 254–263. https://doi.org/10.12816/0036081

Abdulrahaman, M. D., Faruk, N., Oloyede, A. A., Surajudeen– Bakinde, N. T., Olawoyin, L. A., Mejabi, O. V., Imam– Fulani, Y. O., Fahm, A. O., & Azeez, A. L. (2020). Multimedia tools in the teaching and learning processes: A systematic review. *Heliyon, 6*(11), Article: 05312. https://doi.org/10.1016/j.heliyon.2020.e05312

Abu Bakar, F., Abdullah, Z., Sharif, Z., & Mohd. Ariff, A. H. (2021). A preliminary study on the readiness of blended learning among lecturers at Universiti Utara Malaysia. *Practitioner Research, 3,* 57-74. https://doi.org/10.32890/pr2021.3.3

Affum, M. Q. (2022). The effect of internet on students' studies: A review the effect of internet on students. *Library Philosophy and Practice,* Article: 6932.

Alexander, P. A., Jetton, T. L., & Kulikowich, J. M. (1995). Interrelationship of knowledge, interest and recall: Assessing a model of domain learning. *Journal of Educational Psychology, 87,* 559–575. https://doi.org/10.1037/0022–0663.87.4.559

Allman, B., Kimmons, R., Wang, W., Bao, H., Rosenberg, J. M., & Koehler, M. J. Trends and Topics in Educational Technology, 2024 Edition. *TechTrends*, 1–9. https://doi.org/10.1007/s11528–024–00950–5

Almulla, M. A. (2020). The effectiveness of the Project– based Learning (PBL) approach as a way to engage students in learning. *SAGE Open, 10*(3), 1–15. https://doi.org/10.1177/2158244020938702

Anderman, E. M., Sinatra, G. M., & Gray, D. L. (2012). The challenges of teaching and learning about science in the twenty–first century: exploring the abilities and constraints of adolescent learners. *Studies in Science Education, 48*(1), 89–117. https://doi.org/10.1080/03057267.2012.655038

Barrow, L. (2010). Encouraging creativity with scientific inquiry. *Creative Education, 1,* 1–6. https://doi.org/10.4236/ce.2010.11001.

Belagra, M., & Draoui, B. (2018). Project– based Learning and information and communication technology's integration: Impacts on motivation. *International Journal of Electrical Engineering & Education, 55*(4), 293–312. https://doi.org/10.1177/0020720918773051

Brame, C. J. (2016). Effective educational videos: Principles and guidelines for maximizing student learning from video content. *CBE Life Science Education, 15*(4), Article: 6. https://doi.org/10.1187/cbe.16–0

ChanLin, L. (2008). Technology integration applied to project– based learning in science. *Innovations in Education and Teaching International, 45*(1), 55–65. https://doi.org/10.1080/14703290701757450

Chen, C. H., & Yang, Y. C. (2019). Revisiting the effects of project– based learning on students' academic achievement: A meta– analysis investigating moderators. *Educational Research Review*, *26*, 71–81. https://doi.org/10.1016/j.edurev.2018.11.001

Clark, l., P., & Creswell, J., W. (2015*). Understanding research*. New Jersey: Pearson Education

Davis, E. A., & Miyake, N. (2004). Exploration of scaffolding in complex systems. *The Journal of the Learning Sciences,13*(3), 265– 272. https://doi.org/10.1207/s15327809jls1303_1

Abreu, G. (2023). Preliminary literature review: A guide for effective research. mind the graph blog. Retrieved from https://mindthegraph.com/blog/preliminary-literature-review/

Dehaan, R. L. (2012). Teaching creative science thinking. *Science, 334*(6062), 1499–1500. https://doi.org/10.1126/science.1207918

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.2018.02.004

Department for Education and Skills/Qualification and Curriculum Authority (DfES & QCA). (2004). *Science—the national curriculum for England.* HMSO.

Disney, L., & Geng, G. (2022). Investigating young children's social interactions during digital play. *Early Childhood Education Journal, 50*(8), 1449–1459. https://doi.org/10.1007/s10643–021–01275–1

Domenici, K., & Littlejohn, S. (2000). *Mediation: Empowerment in conflict management.* Illinois: Waveland Press.

Erviana, V. Y., 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. https://doi.org/10.47750/pegegog.12.02.15

Evelyn. (2024). The future of education: Technology in the classroom. Retrieved on April 21st, 2024, from https://www.fineshare.com/resource/technology–in–the– classroom.html

Ferrero, M., Vadillo, M. A., Leo´n, S. P. (2021). Is project– based learning effective among kindergarten and elementary students? A systematic review. *PLoS ONE 16*(4), Article: 0249627. https://doi.org/10.1371/journal.pone.0249627Editor

Ginzburg, T., & Barak, M. (2023). Technology–enhanced learning and its association with motivation to learn science from a cross–cultural perspective. *Journal of science education and technology,* 1–10. https://doi.org/10.1007/s10956–023–10048–x

Ghoshal, S. (2023). The effect of internet on students' studies – A review. *EPRA International Journal of Multidisciplinary Research, 9*(7), 38– 42.

Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project– based learning in higher education: Student outcomes and measures. *International Journal of Educational Research, 102,* Article: 101586. https://doi.org/10.1016/j.ijer.2020.101586

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers, 3,* 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Harlen, W. & Deakin Crick, R. (2003). Testing and motivation for learning. *Assessment in Education, 10*(2) 169–208. https://doi.org/10.1080/0969594032000121270

Hodges, G. W., Flanagan, K., Lee, K., Cohen, A., Krishnan, S., & Ward, C. (2020). A quasi–experimental study comparing learning gains associated with serious educational gameplay and hands–on science in elementary classrooms. *Journal of Research in Science Teaching, 57*(9), 1460–1489. https://doi.org/10.1002/tea.21661

Hoisington, C. (2024). Science in preschool, part 1: Leveraging the power of the Next Generation Science Standards (NGSS) with consideration to Developmentally Appropriate Practice (DAP). *Science and Children, 61*(1), 6–10. https://doi.org/10.1080/00368148.2023.2292324

Hrastinski, S. (2019). What do we mean by blended learning? *TechTrends, 63*(5), 564–569. https://doi.org/10.1007/s11528– 019– 00375– 5

Idris, R., Govindasamy, P., & Nachiappan, S. (2023). Challenge and obstacles of STEM education in Malaysia. *International Journal of Academic Research in Business and Social Sciences, 13*(4), 820–828. http://dx.doi.org/10.6007/IJARBSS/v13–i4/16676

Ilomäki, L., & Lakkala, M. (2018). *Digital technology and practices for school improvement: Innovative digital school model. Research And Practice in Technology Enhanced Learning, 13*(1), 1– 32. https://doi.org/10.1186/s41039–018– 0094–8

Janghorban, R., Roudsari, R. L., & Taghipour, A. (2014). Skype interviewing: The new generation of online synchronous interview in qualitative research. *International Journal of Qualitative Studies on Health and Well-Being, 9*(1), Article: 24152. https://doi.org/10.3402/qhw.v9.24152

Jekri, A., & Han, C. G. K. (2020). The challenges in implementing STEM teaching and learning in secondary schools. *International Journal of Education, Psychology and Counselling, 5*(34), 80–90. https://doi.org/10.35631/IJEPC.53400

Kaptan, K., & Timurlenk. (2012). Challenges for science education. *Procedia – Social and Behavioral Sciences, 51*, 763–771. https://doi.org/10.1016/j.sbspro.2012.08.237

Kaya, Z., & Kaya, O. N. (2022). Comparison of inclusive and traditional science classrooms: middle school students' attitudes towards science. International *Journal of Inclusive Education, 26*(11), 1103–1124. https://doi.org/10.1080/13603116.2020.1841839

Kiger, M. E., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical Educator, 42*(8), 846–854. https://doi.org/10.1080/0142159X.2020.1755030

Kılıç, I., & Ulu, M, Ö. (2022). The effect of project– based learning approach on student achievement in life science course in primary education. *African Educational Research Journal, 10*(3), 321– 328. https://doi.org/10.30918/AERJ.103.22.046

Krajcik, J. S., & Blumenfeld, P. C. (2006). *Project– based Learning*. Cambridge University Press

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project– based Learning: A review of the literature. *Improving School, 19*(3), 1–11. https://doi.org/10.1177/1365480216659733

Machmud, M. T., Widiyan, A. P., & Ramadhani, N. R. (2021). The development and policies of ICT supporting educational technology in Singapore, Thailand, Indonesia, and Myanmar. *International Journal of Evaluation and Research in Education, 10*(1), 78–85. https://doi.org/10.11591/ijere.v10i1.20786

Machado, J. M. (2016). *Early childhood experiences in language arts*. Cengage Learning.

Makaramani, R. (2015). 21st century learning design for a telecollaboration project. *Procedia Social Behaviour Science, 191,* 622–627. https://doi.org/10.1016/j.sbspro.2015.04.567

Markula, A., Aksela, M. 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

Muchsin & Mariati. (2020). Application of Project based Learning models in improving creative thinking of students at physics lessons in SMA Bandar Baru. *Budapest International Research and Critics Institute– Journal 3*(2), 1453–1458. https://doi.org/10.33258/birci.v3i2.1008.

Mulyaningsih, D. U., & Arifin, R. A. (2021). Teacher professional development: A study of motivating factors between novice and experienced teachers. *Journal of English Pedagogy and Applied Linguistics, 2*(1), 1-11. https://doi.org/10.32627/jepal.v2i1.57

Munkebye, E., & Staberg, R. L. (2023). Qualifying the science experiences of young students through dialogue – A Norwegian lesson study. *Cogent Education, 10*(1), Article: 2164006. https://doi.org/10.1080/2331186X.2022.2164006

Nathaniela, H., & Esfandiari, N. S. (2023). The influence of the use of learning technology on student learning performance in middle school. *Jurnal Pendidikan Merdeka Belajar, 1*(1), 1– 6.

National Research Council (NRC). (2012*). A framework for K–12 science education: Practices, crosscutting concepts, and core ideas*. The National Academies Press.

National Research Council (NRC). (2013). *Next generation science standards: For states, by states*. The National Academies Press.

Novak, A. M., & Krajcik, J. S. (2020). In M. Moallem, W. Hung, & N. Dabbagh (Eds.), *A case study of project– based learning of middle school students exploring water quality,* (pp. 551–527). The Wiley handbook of problem– based learning. https://doi.org/10.1002/9781119173243.ch24.

Nurhidayah, I. J., Wibowo, F. C., & Astra, I. M. (2021). Project Based Learning (PjBL) learning model in science. learning: Literature review. *Journal of Physics: Conference Series,* Article: 012043. https://doi.org/10.1088/1742– 6596/2019/1/012043

Ong, E. T., Luo, X., Yuan, J., & Yingprayoon, J. (2020). The Effectiveness of Professional development programme on the use of STEM–based 5E inquiry learning model for science educators in China. *Science Education International, 31*(2), 179–184. https://doi.org/10.33828/sei.v31.i2.7.

Ortega– Sánchez D, & Jiménez– Eguizábal, A. (2019). Project– based learning through information and communications technology and the curricular inclusion of social problems relevant to the initial training of infant school educators. *Sustainability, 11*(22), Article: 6370. https://doi.org/10.3390/su11226370

Ong., E. T., Govindasamy, D., & Singh, C. K. S. (2021). The 5E inquiry learning model: Its effect on the learning of electricity among Malaysian students. *Cakrawala Pendidikan, 40*(1), 170–182. https://doi.org/10.21831/cp.v40i1.33415

Peterson, S. S., McIntyre, L. J., & Forsyth, D. (2016). Supporting young children's oral language and writingdevelopment: Educators' and early childhood educators' goals and practices. *Australasian Journal of Early Childhood, 41*(3), 11–19. https://doi.org/10.1177/183693911604100303

Phang, W. L. A., Chong, M. C., Che Mustafa, M., & Mohd Jamil, M. R. (2023). Issues and challenges for the implementation of preschool stream education: What do the preschool educators say? *Southeast Asia Early Childhood Journal, 12*(1), 54–69. https://doi.org/10.37134/saecj.vol12.1.5.2023

Pugh, K. J., Kriescher, D.P.J., Tocco, A.J. et al. The seeing science project: Using design–based research to develop a transformative experience intervention. Journal of *Science Education and Technology, 32,* 338–354. https://doi.org/10.1007/s10956–023–10031–6

Puntambekar, S., & Hubscher, R. (2005). Tools for scaffoldingstudents in a complex learning environment: What have wegained and what have we missed? *Educational Psychologist, 40*(1), 1–12. https://doi.org/10.1207/s15326985ep4001_1

Rahmawati, R., Suryani, N., Akhyar, M., & Sukarmin. (2020). Technology–integrated Project–based Learning for pre–service educator education: A systematic literature review. *Open Engineering, 10*(1), 620–629. https://doi.org/10.1515/eng–2020–0069

Ramadhan, M. (2021). Application of the Project based Learning (PJBL) Learning model to increase student activity and learning outcomes. *Jurnal Guru Komputer, 2*(2), 67–74.

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

Robinson, R.S. (2014). Purposive sampling. In: Michalos, A.C. (Ed), *Encyclopedia of Quality of Life and Well-Being Research*. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-0753-5_2337

Roche, J., Bell, L., Galvão, C., Golumbic, Y. N., Kloetzer, L., Knoben, N., Laakso, M., Lorke, J., Mannion, G., Massetti, L., Mauchline, A., Pata, K., Ruck, A., Taraba, P., & Winter, S. (2020). Citizen Science, Education, and Learning: Challenges and Opportunities. *Front. Sociology, 5,* Article: 613814. https://doi.org/10.3389/fsoc.2020.613814

Rohman, F., Fauzan, A., & Yohandri. (2019). Integration of technology in Project based Learning with tracker on practicum activities. *Journal of Physics: Conference Series, 1185,* Article: 012036. https://doi.org/1088/1742– 6596/1185/1/012036

Russell, D. R. (2002). Looking beyond the interface activity theory and distributed learning. In M. Lea, & K. Nicoll (Eds.), *Distributed learning social and cultural approaches to practice (*pp. 64– 82). New York: RoutledgeFalmer.

Samsudin, M. A., Jamali, S. M.., Md Zain, A. N., & Ebrahim, N. A. (2020). The effect of STEM Project based Learning on self– efficacy among high– school physics students. *Journal of Turkish Science Education, 17*(1), 94–108. http://dx.doi.org/10.2139/ssrn.3574024

Santyasa, I, W., Rapi, N. K., & Sara, I. W. W. (2020). Project Based Learning and academic procrastination of students in learning physics. *International Journal of Instruction, 13*(1), 489–508. https://doi.org/10.29333/iji.2020.13132a

Silander, P., Riikonen, S., Seitamaa–Hakkarainen, P., & Hakkarainen, K. (2022). Learning computational thinking in phenomenon–based co–creation projects – Perspectives from Finland. In S.–C. Kong & H. Abelson (Eds.), *Computational thinking education in K–12: Artificial intelligence literacy and physical computing* (pp. 103–119). MIT. https://doi.org/10.7551/mitpress/13375.003.0008.

Sithu, M. S. (2021). *The affect of technology supported Project– based Learning for students with diverse abilities* [Doctoral Dissertation, Aspen University]

Smith, P. G., Morrow, R. H., & Ross, D. A. (2015*). Field trials of health interventions*: *A toolbox (3rd ed.).* OUP Oxford.

Parker, C., Scott, S., & Geddes, A. (2019). *Snowball sampling.* SAGE Research Methods Foundations.

Soratto. J., Pires, D. E. P., & Friese, S. (2020). Thematic content analysis using Atlas.ti software: potentialities for research in health. *Revista Brasileira de Enfermagem, 73*(3), Article: 20190250. http://dx.doi.org/10.1590/0034–7167–2019–0250

Sormunen, K., Vehmaa, S., Seitamaa–Hakkarainen, P., Lavonen, J., Hakkarainen, K., & Juuti, J. (2023). Learning science through a collaborative invention project in primary school. *Disciplinary and Interdisciplinary Science Education Research, 5*(6), 1–15. https://doi.org/10.1186/s43031–023–00074–5

Shpeizer, R. (2019). Towards a successful integration of project– based learning in higher education: Challenges, technologies and methods of implementation. *Universal Journal of Educational Research 7*(8), 1765–1771. https://doi.org/10.13189/ujer.2019.070815

Stulberg, J. & Love, L. (2009). *The middle voice.* North Carolina: Carolina Academic Press.

Subramanian, N. K. (2023). *Technology in education: a case study on Malaysia.* Paris, France: UNESCO–Global Education Monitoring Report Team.

Tanner K. D. (2013). Structure matters: Twenty– one teaching strategies to promote student engagement and cultivate classroom equity. *CBE Life Sciences Education, 12*(3), 322–331. https://doi.org/10.1187/cbe.13– 06– 0115

Thompson, I. (2013). The mediation of learning in the Zone of Proximal Development through a Co– constructed Writing Activity. *Research in the Teaching of English, 47*(3), 247–276. http://www.jstor.org/stable/24397856

Umugiraneza, O., Bansilal, S. & North, D. (2018). Exploring educators' use of technology in teaching and learning mathematics in KwaZuluNatal schools. *Pythagoras, 39*(1), Article: 342. https://doi. org/10.4102/pythagoras. v39i1.342

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

Weintrop, D., Beheshti, E., Horn, M., Orton, K., Jona, K., Trouille, L., & Wilensky, U. (2016). Defining computational thinking for mathematics and science classrooms. *Journal of Science Education and Technology, 25*(1), 127–147. https://doi.org/10.1007/s10956–015–9581–5

Wertsch, J. V. (1991). Voices of the mind: *A sociocultural approach to mediated action*. Cambridge, MA: Harvard University Press.

Wertsch, J. V., Minick, N., & Arns, F. J. (1984). The creation of context in joint problem–solving. In B. L. Rogoff, J. (Ed.), *Everyday cognition: Its development in social context* (pp.151– 171). Cambridge, MA: Harvard University Press.

Widyasari, W., Rasmitadila, R., Asri, M. H., Rusmiati, A., Abdul, G. A., & Reza, R. (2019). Preliminary study on the development of blended learning (BLM) model: Based on needs analysis and learning independence. *Journal of Physics: Conference Series, 1175,* 1-5. https://doi.org/10.1088/1742-6588/1175/1/012012

Willemsen, R. H., de Vink, I. C., Kroesbergen, E. H., & Lazonder, A. W. (2023). The role of creative thinking in children's scientific reasoning. *Thinking Skills and Creativity, 49,* Article: 101375. https://doi.org/10.1016/j.tsc.2023.101375

Wirajing, M. A. K., & Nchofoung, T.N. (2023). The role of education in modulating the effect of ICT on governance in Africa. *Education and Information Technology, 28,* 11987–12020. https://doi.org/10.1007/s10639–023–11631–w

Wilson, K., & Korn, J. (2007). Attention during lectures: Beyond ten minutes. *Teaching of Psychology, 34,* Article: 8589. https://doi.org/10.1177/009862830703400202

Yeop, M. A., & Gapor, A. L. H. (2012). The effects of the Project– based Learning approach technology on student achievement and acceptance. *Jurnal Bitara, 5,* 31– 45.

Yılmaz, Ö. (2023). The role of technology in modern science education. In Baltacı, Ö. (Ed.) *Current research in education – VI* (pp. 35–60). Erzincan Binali Yıldırım University. https://doi.org/10.58830/ozgur.pub383.c1704

Zhang, W. (2022) The Role of Technology–based Education and educator professional development in english as foreign language classes. *Front. Psychology, 13,* Article: 910315. https://doi.org/10.3389/fpsyg.2022.910315