International Journal of Advanced Research in Education and Society
e-ISSN: 2682-8138 | Vol. 8, No. 2, 522-531, 2026
https://asianscholarsnetwork.com/asnet-journals

Teachers' Perceptions of the Effectiveness of Inquiry-Based Science Education (IBSE) in Enhancing Active Learning Among SJKT Students in Klang Valley

Kanakesvary Poongavanam[1*], Rosinah Mahmood[1], Nithyavani Manikam[1], Puvaneswaran Parmasivam[1]

[1] Open University Malaysia, No. 86, Jalan Dato' Bandar Tunggal, 70000 Seremban, Negeri Sembilan, Malaysia

*Corresponding Author: kanakes23@oum.edu.my

Received: 10 January 2026 | Accepted: 25 March 2026 | Published: 1 April 2026

DOI: https://doi.org/10.55057/ijares.2026.8.2.41

Abstract: *Inquiry-Based Science Education (IBSE) is widely recognized as an effective pedagogical approach for promoting active learning and scientific inquiry. However, empirical evidence on its effectiveness within Tamil national-type primary schools (SJKT) in Malaysia remains limited, particularly in multilingual classroom contexts. This study investigates the effectiveness of IBSE in enhancing active learning among SJKT students in Klang Valley, as perceived by science teachers. Specifically, it examines changes in students' inquiry-based learning skills across five domains—conception, implementation, analysis, communication, and application—before and after the implementation of IBSE. The study also explores teachers' perceptions of IBSE effectiveness, the challenges encountered during implementation, and their suggestions for improvement. An explanatory sequential mixed-methods design was employed. Quantitative data were collected through pre- and post-intervention surveys administered to 200 SJKT science teachers using a structured Likert-scale instrument. The data were analyzed using descriptive statistics and paired-sample t-tests to determine differences in teachers' perceptions before and after the intervention. Qualitative data were gathered through semi-structured interviews with 20 purposively selected teachers and analyzed using Braun and Clarke's six-phase thematic analysis. The findings are expected to demonstrate significant improvements in students' inquiry-based active learning skills following IBSE implementation. Qualitative results are anticipated to reveal key challenges such as time constraints, limited resources, and the need for targeted professional development, alongside practical teacher-driven recommendations. This study contributes to the literature by providing context-specific evidence on IBSE in SJKT classrooms and offers actionable insights for educators, curriculum developers, and policymakers to strengthen inquiry-based science education in multicultural and multilingual primary school settings in Malaysia.*

Keywords: Inquiry-Based Science Education, Active Learning, SJKT, Science Education, Klang Valley, Malaysia

1. Introduction

Science education plays a pivotal role in equipping students with the knowledge, skills, and attitudes necessary for success in the 21st century, where critical thinking, problem-solving, and collaboration are highly valued. Among the pedagogical approaches advocated globally,

Inquiry-Based Science Education (IBSE) has emerged as a powerful method for fostering active learning, enabling students to construct knowledge through questioning, investigation, analysis, and communication (Aidoo, 2024; Pauletti & Morais, 2022). IBSE aligns with constructivist principles, positioning learners as active participants who engage with scientific concepts through hands-on exploration and reflective thinking (Qablan et al., 2024). Research across different educational contexts has shown that IBSE not only improves conceptual understanding but also strengthens higher-order thinking, communication, and application skills (Ješková et al., 2022; Soomro et al., 2025). In Malaysia, the National Education Blueprint (2013–2025) emphasises student-centred and inquiry-oriented learning to raise science achievement and engagement (Ong, 2022). However, studies indicate that primary school implementation, particularly in Sekolah Jenis Kebangsaan Tamil (SJKT), faces challenges such as limited teacher expertise, large class sizes, and lack of resources (Murugayya & Nachiappan, 2022; Roslan et al., 2023). These issues hinder teachers from fully applying IBSE skills across conception, implementation, analysis, communication, application, and assessment stages, which are crucial for fostering active learning behaviors.

2. Background of the Study

The way we teach and learn science is changing. Traditional methods where the teacher does all the talking are being replaced by new approaches that focus on the student. This is because the old ways didn't help students develop important skills like critical thinking, creativity, and problem-solving. These skills are essential for success in today's fast-changing world. To address this, many schools are now using a student-centered approach called Inquiry-Based Science Education (IBSE). This method is based on the idea that students learn best when they are actively involved in the learning process. They investigate, gather evidence, and discuss their findings, rather than just listening to the teacher. This approach helps students truly understand scientific concepts and develop higher-order thinking skills like analysis and evaluation. Studies have shown that IBSE is effective in improving student understanding and engagement. It also helps students become active learners, taking charge of their own education by asking questions, seeking out resources, and applying what they've learned to new situations. Many countries are now incorporating IBSE into their science curricula, and the results are positive. When teachers use IBSE effectively, students are more engaged and achieve better outcomes. By focusing on the student and encouraging active learning, we can help prepare them for success in an ever-changing world. This new approach to science education is not just about learning facts, but about developing the skills and abilities that students need to thrive. With IBSE, students are not just passive receivers of information, but active participants in the learning process. This is a key part of helping them develop into capable and confident individuals who can make a positive impact in the world. The benefits of IBSE are clear. It helps students develop a deeper understanding of scientific concepts, as well as important skills like critical thinking and problem-solving. It also encourages students to take an active role in their own learning, which is essential for success in today's fast-paced and rapidly changing world. By adopting IBSE, schools can provide students with the skills and knowledge they need to succeed, both in science and beyond. In conclusion, the shift towards student-centered approaches like IBSE is an important step forward in science education.

In Malaysia, the government has made it clear that it wants schools to use a more interactive way of teaching, known as inquiry-driven pedagogy, to help students develop problem-solving skills and a better understanding of science. This approach is part of the country's plan to improve education, which runs from 2013 to 2025. However, putting this plan into action is

proving to be difficult, especially in primary schools like SJKT in the Klang Valley. These schools face unique challenges, such as students from different backgrounds, limited resources, and language barriers, which make it hard to teach in a way that engages all students. Despite the government's support for this new approach, many teachers in these schools still rely on traditional methods that focus on memorization rather than hands-on learning. This is a concern because students need to develop their investigative skills to succeed in science. Teachers often struggle to find the time to design lessons that incorporate inquiry-based learning, and they may not have the necessary training or access to resources like laboratory facilities. These challenges directly affect how well students can learn actively. For inquiry-based science education to be effective, teachers need to be able to design tasks that mimic real scientific investigations, guide students through these investigations, facilitate discussions, and show students how what they're learning applies to the real world. Therefore, it's crucial to understand how well teachers are equipped to teach in this way so that targeted support can be provided to improve science education in these schools. By addressing these challenges, Malaysia can work toward producing students who are globally competitive and equipped with the skills needed to succeed in science and beyond.

Learning is more effective when teachers have the right skills to make it happen. Research from around the world shows that teachers need to be good at six key things: coming up with ideas, putting them into action, analyzing information, communicating well, applying knowledge, and assessing progress. When teachers are good at these things, they can create lessons that spark curiosity and help students learn by investigating and solving problems. For example, teachers need to be able to design lessons that get students to think and learn, and then guide them through the process of finding answers and solving problems. They also need to be able to help students make sense of the information they collect and encourage them to share their findings with others. Additionally, they need to be able to show students how to use what they've learned to solve real-world problems. Studies have shown that when teachers are good at these things, students are more engaged, they understand things more deeply, and they get better at solving problems. For instance, one study found that when teachers used a structured approach to inquiry-based learning, students became much better at collecting and analyzing data and at making arguments based on evidence. Another study found that when students worked on tasks that were connected to the real world, they were more cognitively and emotionally engaged. All of this suggests that teachers play a crucial role in helping students learn and develop new skills. By improving teachers' skills in inquiry-based learning, we can enhance educational outcomes and help students succeed. This is why it's so important for teachers to have the right training and support to develop their skills in these areas. Some of the key things that teachers need to be able to do include: Designing lessons that stimulate curiosity and encourage investigation, guiding students through the process of collecting and analyzing data, helping students develop evidence-based conclusions, encouraging students to share and discuss their findings, showing students how to apply what they've learned to new contexts and real-world problems , assessing student progress and understanding. By focusing on these areas, teachers can help students develop the skills they need to succeed in school and beyond. And by supporting teachers in their professional development, we can help ensure that students receive the best possible education.

We know that Inquiry-Based Science Education (IBSE) has a lot to offer, but it is not being used consistently. This is a problem because it means we need to do more research that's specific to certain contexts. In Malaysia, people are becoming more interested in how students can learn actively and be engaged in science, technology, engineering, and math (STEM) subjects. However, not many studies have looked at how teachers' IBSE skills affect active

learning outcomes in certain types of schools, like SJKT schools. Some studies have been done, but they show that there are challenges, such as the fact that science lessons often focus too much on covering the syllabus and not enough on exploring and investigating. Teachers can also be hesitant to give up control in the classroom. Moreover, we don't know enough about the specific challenges that SJKT teachers face when trying to use IBSE. Are they not getting enough training? Are they limited by how they have to assess their students? Are there language and communication barriers in classrooms where many languages are spoken? We can look at studies from other countries to get some ideas about common challenges, like big class sizes, insufficient resources, and not enough time. But we need to understand how these issues play out in Malaysian primary schools so we can come up with solutions that really work. It would also be helpful to ask teachers themselves what they think would improve IBSE implementation. By listening to their suggestions, we can come up with practical recommendations that are grounded in the reality of what's happening in local classrooms. This can help bridge the gap between what we know theoretically and what actually happens in practice.

This study aims to achieve three main goals. First, it wants to find out how well teachers at SJKT are able to use Inquiry-Based Science Education (IBSE) skills in areas like planning, teaching, analyzing, communicating, applying, and assessing, and how these skills relate to active learning. Second, it seeks to understand how each of these skill areas affects the outcomes of active learning. Third, it looks to identify the challenges teachers face in implementing IBSE and gather their suggestions for improvement. To do this, the study combines numerical data from surveys with a deeper analysis of open-ended questions, allowing for a thorough understanding of how IBSE skills are used, their impact on active learning, and the factors that influence their use. The results of this study are expected to contribute to both theory and practice by providing evidence of the link between IBSE and active learning in Malaysian primary schools and offering practical strategies to improve science education. The ultimate goal is to help Malaysian students develop the scientific knowledge and problem-solving skills they need to succeed in a complex, knowledge-driven world. By exploring the current state of IBSE implementation and its effects, this research aims to support the development of more effective science education in SJKT classrooms.

3. Problem Statement

Over the past two decades, IBSE has gained prominence in international educational discourse as a transformative approach to science teaching, supported by empirical evidence showing its capacity to improve student engagement, conceptual understanding, and critical thinking (Pauletti & Morais, 2022; Ješková et al., 2022; Soomro et al., 2025). The approach is grounded in constructivist theory, which views learning as an active process where students build knowledge through questioning, investigation, and reflection (Qablan et al., 2024). While IBSE has been widely adopted in various global contexts, its implementation in Malaysia, and particularly within SJKT in Klang Valley, has been inconsistent and limited in scope (Murugayya & Nachiappan, 2022; Roslan et al., 2023). The Malaysian National Education Blueprint (2013–2025) explicitly calls for student-centred pedagogies to foster higher-order thinking skills and active learning (Ong, 2022). However, classroom practices often remain dominated by teacher-centred instruction, with science lessons emphasising factual recall rather than scientific inquiry (Majid & Badrasawi, 2024). This mismatch between policy and practice reflects a contextual gap that has yet to be addressed through systematic research. In SJKT contexts, challenges such as linguistic diversity, resource constraints, large class sizes, and limited professional development opportunities for teachers exacerbate the difficulty of

implementing IBSE effectively (Shanmugam & Balakrishnan, 2019). Although international studies have documented similar barriers in other countries (Pauletti & Morais, 2022; Strat et al., 2024), the specific ways in which these challenges affect IBSE in Malaysian SJKT classrooms, and their impact on active learning, remain underexplored.

A second gap lies in the lack of focused investigation into the relationship between teachers' IBSE skills and active learning outcomes in the Malaysian primary school context. IBSE is a multi-dimensional pedagogy encompassing skills in conception (designing inquiry-based lessons), implementation (facilitating investigations), analysis (interpreting and guiding data-driven conclusions), communication (promoting discussion and presentation of findings), and application (transferring knowledge to new contexts) (Aidoo, 2024; Ješková et al., 2022). However, assessment has rarely been conceptualised as a distinct teacher skill domain in past studies, often treated instead as an outcome measure rather than an integral part of the inquiry process. Recent research highlights that formative and authentic assessment practices are central to reinforcing inquiry, validating student reasoning, and sustaining active learning (Aidoo, 2024; Vilela et al., 2025). This study therefore extends the traditional IBSE framework by incorporating assessment as a sixth domain, addressing a critical gap in the literature and recognising its role as a pedagogical competency that shapes inquiry-based teaching and learning. Research in other contexts has demonstrated that proficiency in these domains contributes directly to students' active engagement and learning (Attard et al., 2021; Harrison, 2025). For example, Ješková et al. (2022) found that structured IBSE interventions improved inquiry skills such as data accuracy and argumentation, while Kamarrudin et al. (2023) showed that active learning strategies enhanced higher-order thinking among pre-service teachers. Yet, despite the conceptual clarity provided by these international studies, there is minimal empirical evidence from Malaysia examining how each IBSE skill domain, including assessment, relates to active learning, particularly in SJKT settings. Without such evidence, it is difficult for policymakers and educators to prioritise training and resources in the skill areas most likely to enhance student outcomes. This variable gap is significant because it prevents the development of targeted interventions that could strengthen both teaching quality and student learning experiences in primary science education.

The third gap concerns methodological limitations in existing Malaysian research on IBSE and active learning. Much of the literature on science pedagogy in Malaysia has been descriptive or anecdotal, focusing on teacher perceptions or general challenges without employing robust, mixed-method research designs (Murugayya & Nachiappan, 2022; Roslan et al., 2023). Internationally, mixed-method approaches have been used to capture both the measurable relationships between variables and the nuanced, context-specific experiences of teachers and students (Braun & Clarke, 2006; Majid & Badrasawi, 2024). By combining quantitative techniques such as descriptive statistics, correlation, and regression analysis with qualitative thematic analysis, researchers can provide a more comprehensive understanding of pedagogical effectiveness and implementation barriers (Soomro et al., 2025). In Malaysia, however, there is a paucity of studies that integrate quantitative measures of IBSE skills and active learning with qualitative insights into implementation challenges. As a result, existing findings often lack depth, failing to connect observed teaching practices with measurable impacts on student engagement and learning outcomes. This methodological gap underscores the need for research that employs a rigorous, mixed-method design to capture both the statistical relationships and the lived realities of IBSE in SJKT classrooms.

The fourth gap relates to the practical application of existing knowledge about IBSE in the Malaysian primary school context. While numerous studies have identified common

challenges to IBSE implementation, such as limited resources, inadequate training, and time constraints (Majid & Badrasawi, 2024; Pauletti & Morais, 2022), few have moved beyond problem identification to propose evidence-based, context-specific solutions. Teachers themselves are a valuable source of practical insight, as they navigate the complexities of implementing IBSE in real classrooms. Yet, in Malaysia, limited research has systematically documented teachers' suggestions for improving IBSE, particularly in the multilingual, culturally specific environment of SJKT schools (Shanmugam & Balakrishnan, 2019). International studies suggest that teacher-generated strategies can be instrumental in developing professional development programs and resource allocation policies that are both feasible and effective (Attard et al., 2021; Harrison, 2025). The absence of such research in Malaysia means that interventions are often designed without sufficient grounding in the day-to-day realities of teachers, reducing their relevance and impact. Addressing this practical gap is essential for ensuring that IBSE reforms are not only theoretically sound but also operationally viable in local contexts.

Given these gaps, this study is positioned to make a significant contribution to both theory and practice. By examining the level of teachers' IBSE skills in the six domains of conception, implementation, analysis, communication, application, and assessment; determining the relationship between each of these skills and active learning outcomes; and exploring the challenges and teacher-generated suggestions for improving IBSE implementation, the research will provide a holistic understanding of IBSE in SJKT science classrooms. The mixed-method design will allow for triangulation of quantitative and qualitative findings, ensuring that the results are both statistically robust and contextually rich (Braun & Clarke, 2006). This approach aligns with the call for research that not only measures educational variables but also engages deeply with the contextual realities of teaching and learning (Soomro et al., 2025; Pauletti & Morais, 2022). Ultimately, the study aims to inform policy, teacher training, and resource allocation, thereby supporting the effective integration of IBSE into Malaysian primary science education and contributing to the broader goal of fostering active, independent, and scientifically literate learners.

4. Research Objective

The research objectives of this study are as follows:

i. **RO1:** To examine the level of SJKT teachers' IBSE skills (conception, implementation, analysis, communication, application, and assessment) in relation to active learning among SJKT students in Klang Valley.
ii. **RO2:** To determine the relationship between SJKT teachers' IBSE skills (conception, implementation, analysis, communication, application, and assessment) and active learning among SJKT students in Klang Valley.
iii. **RO3:** To explore the challenges faced and suggestions provided by SJKT teachers regarding the implementation of IBSE to enhance active learning among SJKT students in Klang Valley.

5. Research Questions

The research questions of this study are as follows:

i. **RQ1:** What is the level of SJKT teachers' IBSE skills (conception, implementation, analysis, communication, application, and assessment) in relation to active learning among SJKT students in Klang Valley?

ii. **RQ2:** What is the relationship between SJKT teachers' IBSE skills (conception, implementation, analysis, communication, application, and assessment) and active learning among SJKT students in Klang Valley?
iii. **RQ3:** What are the challenges faced and suggestions provided by SJKT teachers regarding the implementation of IBSE to enhance active learning among SJKT students in Klang Valley?

6. Research Hypotheses

The hypotheses are developed for Research Objective 2 (RO2), which aims to determine the relationship between SJKT teachers' IBSE skills, covering conception, implementation, analysis, communication, application, and assessment, and active learning among SJKT students in Klang Valley. Each hypothesis focuses on one specific IBSE skill dimension to assess its individual influence on active learning. The research hypotheses of this study are as follows:

i. **H1:** There is a significant relationship between SJKT teachers' conception skills in IBSE and active learning among SJKT students in Klang Valley.
ii. **H2:** There is a significant relationship between SJKT teachers' implementation skills in IBSE and active learning among SJKT students in Klang Valley.
iii. **H3:** There is a significant relationship between SJKT teachers' analysis skills in IBSE and active learning among SJKT students in Klang Valley.
iv. **H4:** There is a significant relationship between SJKT teachers' communication skills in IBSE and active learning among SJKT students in Klang Valley.
v. **H5:** There is a significant relationship between SJKT teachers' application skills in IBSE and active learning among SJKT students in Klang Valley.
vi. **H6:** There is a significant relationship between SJKT teachers' assessment skills in IBSE and active learning among SJKT students in Klang Valley.

7. Significance of the Research

7.1 Practical perspective

From a **practical perspective**, it addresses key challenges in Malaysian SJKT science classrooms—such as limited resources, large class sizes, and reliance on rote learning—by examining how teachers' IBSE (Inquiry-Based Science Education) skills influence active learning. The findings will help educators and policymakers design targeted professional development, improve resource allocation, and implement context-appropriate strategies to enhance inquiry-based teaching and student engagement.

7.2 Theoretical Perspective

From a **theoretical perspective**, the study contributes to the literature by explicitly linking six IBSE skill domains to active learning behaviors in primary education, particularly within Malaysia's multilingual SJKT context. Using a mixed-method approach, it deepens understanding of how teacher competencies shape student engagement while also testing and refining constructivist and active learning theories in a local setting.

7.3 Future Research

In terms of **future research**, the study provides a foundation for further investigations, including longitudinal, experimental, and comparative studies across different school contexts. It also highlights systemic challenges and opportunities for innovation, such as integrating

technology into IBSE and exploring equity in minority-language education. Overall, the research bridges theory and practice while supporting ongoing improvements in science education locally and globally.

8. Limitation of the Study

This study is limited by its defined scope, variables, and context. It focuses on six IBSE skill domains—conception, implementation, analysis, communication, application, and assessment—as independent variables, with active learning as the only dependent variable. The inclusion of **assessment** as a separate domain is a notable limitation, as most prior research treats it as integrated within other domains. Although its inclusion broadens the analysis, findings related to assessment are exploratory and require further validation. The study also excludes other influential factors such as school leadership, parental involvement, and institutional culture, limiting its ability to capture the full educational context. Additionally, it focuses solely on active learning behaviors rather than academic outcomes like test scores, and its cross-sectional design prevents establishing causal relationships. Contextually, the research is confined to SJKT schools in Klang Valley, making the findings less generalisable to other Malaysian school types. The sample size, while adequate, is relatively small, and voluntary participation may introduce self-selection bias, potentially skewing results toward teachers more inclined toward IBSE.

9. Conceptual Framework

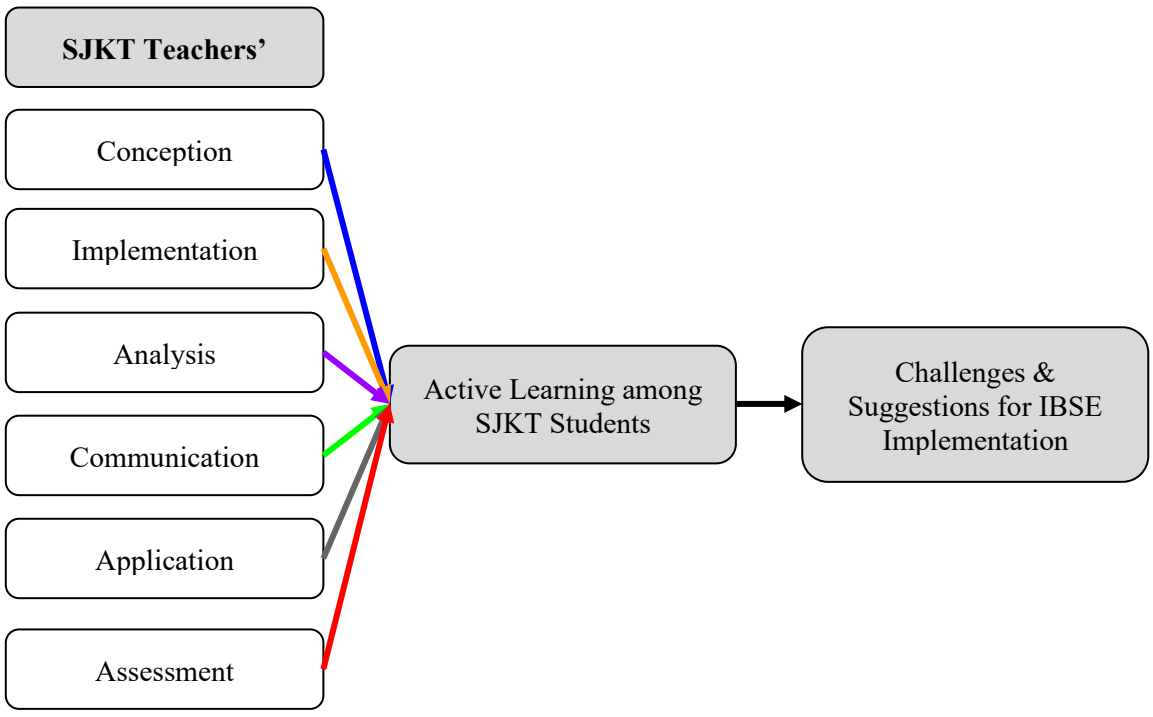

Figure 1.1: Conceptual Framework

This section explains five key IBSE (Inquiry-Based Science Education) skill dimensions—conception, implementation, analysis, communication, and application—and their relationship with active learning in SJKT classrooms.

Conception involves designing meaningful, inquiry-based lessons that stimulate curiosity and are accessible to diverse learners. Strong planning encourages active participation, while poor

planning leads to disengagement.**Implementation** focuses on how teachers carry out inquiry lessons, balancing guidance and student autonomy. Effective implementation increases motivation and engagement, even in resource-limited settings. **Analysis** refers to guiding students in interpreting data and developing critical thinking. Strong analytical support promotes deeper understanding, while weak guidance results in superficial learning. **Communication** emphasizes sharing ideas through discussions, presentations, and writing. It enhances collaboration, understanding, and language development, especially in multilingual contexts. **Application** involves helping students transfer knowledge to real-world situations, reinforcing relevance and sustaining long-term engagement. Overall, these IBSE skill dimensions are proposed to positively influence active learning, though factors like resources, class size, and language diversity may affect their impact. The study aims to identify which skills most strongly predict active learning and to inform improvements in teaching practices, training, and curriculum design in Malaysian primary science education.

10. Conclusion

This chapter establishes the foundation for the study by highlighting IBSE as a constructivist, student-centered approach aligned with Malaysia's National Education Blueprint (2013–2025). It identifies key research gaps in Malaysian primary education, particularly the lack of studies linking teachers' IBSE skills to active learning and the need for context-specific strategies in SJKT classrooms. The study aims to examine six IBSE skill domains—conception, implementation, analysis, communication, application, and assessment—and their relationship with students' active learning, while also exploring contextual challenges and teacher recommendations. A conceptual framework, along with research objectives, questions, and hypotheses, guides the investigation. The chapter also outlines the study's significance in informing teaching practices, policy, and future research, while acknowledging its limitations in scope, context, and methodology. Overall, it justifies the research as a meaningful contribution to improving science education and fostering active, independent learners in SJKT and similar contexts.

Acknowledgement

All praise and gratitude to God for His abundant grace, strength, and inspiration bestowed throughout the process of researching and writing this thesis. This thesis would not have been completed without the support, guidance, and encouragement from various parties.

Conflict of Interest Statement

The author(s) declare that there is no conflict of interest regarding the publication of this article. This research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

Agustini, R., Meilanie, R., S. M., & Pujiastuti, S. I. (2024). Enhancing critical thinking and curiosity in early childhood through inquiry-based science learning. *Aulad: Journal on Early Childhood, 7*(3), 734–743.

Aidoo, B. (2024). A reflective study on adopting inquiry-based science teaching methods. *Disciplinary and Interdisciplinary Science Education Research, 6*(1), 29.

Alqawasmi, A., Alsalhi, N., R., & Al Qatawneh, S. S. (2024). The influence of utilizing inquiry-Based Learning Strategy on science accomplishment of primary students' stage. *International Journal of Interactive Mobile Technologies, 18*(5).

Attard, C., Berger, N., & Mackenzie, E. (2021, August). The positive influence of inquiry-based learning teacher professional learning and industry partnerships on student engagement with STEM. In *Frontiers in Education* (Vol. 6, p. 693221). Frontiers Media SA. https://doi.org/10.3389/feduc.2021.693221

Bansal, G., & Ramnarain, U. (2021). Inquiry-based science education in primary schools. *Education 3–13, 49*(3), 259–262.

Baptista, M., Pinho, A., S., & Alves, A. R. (2025). Students' learning for Action Through Inquiry-Based Science Education on a Local Environmental Problem. *Sustainability, 17*(9), 3907.

Bendu, C. (2024). *Impact of STEM on students' intellectual engagement.* https://mspace.lib.umanitoba.ca/items/e33f09cc-d398-43a6-877c-1382377cf236

Blom, S., Pentland, P., & Woolcott, G. (2021). Designing and implementing student-centered STEM practices: The "water in the 21st century" teaching module. *Teaching Science, 67*(1), 22-30.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101.

Bruner, J. S. (1966). *Toward a theory of instruction*. Harvard University Press. https://books.google.com/books?hl=en&lr=&id=28bmEAAAQBAJ&oi=fnd&pg=PA1&dq=Bruner,+J.+S.+(1966).+Toward+a+theory+of+instruction.+Harvard+University+Press.&ots=0qJj1W0lEE&sig=DoXa2KMn_GB6kJOK2iWKl1ZaP40

Choi, Y. H., Theobald, E., Velasco, V., & Eddy, S. L. (2025). Exploring how course social and cultural environmental features influence student engagement in STEM active learning courses: A control–value theory approach. *International Journal of STEM Education, 12*(1), 4.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155–159.

Conceição, T., Baptista, M., & Da Ponte, J. P. (2021). Examining pre-service science teachers' pedagogical content knowledge through lesson study. *Eurasia Journal of Mathematics, Science and Technology Education, 18*(1), em2060.