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Exploring the Experiences and Challenges of Science Teachers in Implementing Practical Assessment in Malaysian Secondary Schools

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Abstract

This study investigates Malaysian secondary school science teachers' experiences and challenges in implementing the SPM Practical Test, a recently introduced component of the national science examination. Employing a qualitative case study design, semi-structured interviews were conducted with six science teachers from four different categories of government secondary schools in Selangor. The analysis revealed that teacher self-efficacy, access to laboratory resources, and the extent of prior professional development significantly shaped the implementation process. Teachers also reported key constraints, including limited laboratory facilities, insufficient student readiness for independent experimentation, and time limitations within the school timetable. These findings highlight the gap between policy aspirations and classroom realities, particularly in the context of fostering practical scientific competencies. This study offers a novel contribution by examining Malaysian secondary science teachers' lived experiences in implementing the SPM Practical Test, integrating perspectives on self-efficacy, resource readiness, and pedagogical adaptation to inform more contextually grounded assessment reforms.

Keywords: SPM Practical Test, Science Education, Teacher Insights, Laboratory Test, Educational Reform

Introduction

In recent years, the Malaysian Ministry of Education has introduced major reforms to the national assessment system, notably through the inclusion of practical and oral components in the *Sijil Pelajaran Malaysia (SPM)* examination. This reform represents a decisive step toward nurturing scientific literacy, inquiry skills, and higher-order thinking (HOTS) among secondary school students. The introduction of the *SPM Practical Test* is particularly

significant, marking a transition from rote-based learning to performance-oriented science assessment.

This national direction aligns with international educational trends that advocate authentic assessment to promote critical thinking, collaboration, and real-world problem-solving (Zhou et al., 2023; Padrón et al., 2024). However, successful reform depends on teachers' capacity to enact policy intentions in the classroom. Despite the reform's promise, gaps remain between policy aspirations and ground-level realities—especially in under-resourced or rural schools. Teachers face challenges such as inadequate laboratory infrastructure, inconsistent professional development, and large class sizes, which collectively hinder the effectiveness of practical assessments.

This study responds to these concerns by examining how secondary science teachers in Malaysia experience, interpret, and manage the implementation of the *SPM Practical Test*. It explores their perceptions of school readiness, student preparedness, pedagogical confidence, and systemic barriers that affect assessment delivery.

This research contributes new insights by foregrounding the teacher's lived experience—an area underexplored in Malaysian science education reform. By linking teacher self-efficacy, resource inequality, and professional support structures, the study adds to the social science discourse on how institutional contexts influence reform implementation. The findings are expected to inform targeted professional development programs and policy strategies that promote equitable, inquiry-based science education across diverse school settings.

The Importance of Practical Work in Science Education

Practical work is a cornerstone of science education, promoting conceptual understanding, scientific reasoning, and learner engagement. It enables students to apply theoretical knowledge in real-world contexts, thereby fostering critical and experimental thinking. However, Malaysian studies indicate persistent challenges in translating theory into meaningful laboratory practice.

Kamarudin, Abdul Latif, and Zakaria (2022) found that many students struggle with basic laboratory procedures despite strong theoretical understanding—a reflection of the limited frequency and quality of lab exposure in schools. Similarly, Ismail and Jusoh (2021) reported that students' confidence in conducting experiments independently correlates strongly with regular hands-on experience. These findings highlight a recurring gap between curriculum goals and classroom realities, underscoring the need for systemic support to bridge the theory–practice divide.

Infrastructure and Resource Challenges in Malaysian Schools

School infrastructure remains a decisive factor in implementing practical assessments effectively. Persistent disparities between urban and rural schools contribute to inequitable access to laboratory facilities. Sivalingam (2024) observed that outdated equipment, insufficient maintenance, and safety limitations remain widespread, particularly outside urban centers.

Tan and Wong (2020) similarly reported that teachers in rural and suburban schools frequently lack essential apparatus and consumables, restricting both the depth and frequency of laboratory work. Consequently, teachers often modify or reduce experiments, diminishing opportunities for students to acquire procedural skills. These structural constraints not only weaken the fidelity of the SPM Practical Test but also reinforce educational inequalities.

Teacher Professional Development and Self-Efficacy

Teacher competence is fundamental to the successful translation of assessment reform into classroom practice. Research consistently shows that continuous professional development (CPD) enhances teacher self-efficacy, pedagogical flexibility, and instructional quality (Zhou et al., 2023; Baysal & Mutlu, 2021).

Padrón, Waxman, and Acosta (2024) found that sustained, collaborative PD programs lead to measurable improvements in inquiry-based teaching and student outcomes. In the Malaysian context, however, many teachers implementing the SPM Practical Test have limited access to targeted training on student-led experimentation. As Othman, Ibrahim, and Salim (2024) observed, such teachers often resort to rigid, teacher-centered practices to maintain control and safety. Thus, empowering teachers through ongoing, context-specific CPD remains essential to building both confidence and capacity for inquiry-based assessment.

Psychological and Safety Considerations in Practical Assessment

Practical assessments extend beyond cognitive competencies—they engage students' emotional readiness, confidence, and attitudes toward experimentation. High-stakes lab assessments can trigger anxiety, especially among students with limited prior exposure. Ismail and Jusoh (2021) reported that this anxiety often manifests as hesitation, procedural errors, or disengagement.

Teachers, aware of safety risks and limited supervision capacity, may restrict student participation in experiments, opting instead for demonstrations (Othman et al., 2024). While this approach mitigates safety concerns, it inadvertently limits students' autonomy and inquiry skills—the very outcomes that practical assessments aim to cultivate.

Toward Equitable and Sustainable Practical Assessment Reform

The introduction of the *SPM Practical Test* is a progressive move toward performance-based learning and authentic assessment in Malaysia. Nevertheless, without sustained infrastructure investment, teacher empowerment, and alignment between policy and practice, the reform risks deepening inequities.

As Padrón et al. (2024) argue, genuine reform requires continuous teacher support, institutional collaboration, and contextual adaptation. Addressing disparities in resource allocation (Sivalingam, 2024) and aligning reforms with classroom realities (Tan & Wong, 2020) are vital for ensuring that the practical test fulfills its transformative potential.

This study advances the discussion by situating teachers at the center of reform analysis, highlighting how their professional agency, resource access, and pedagogical confidence shape the implementation of science assessment policy. In doing so, it bridges educational

policy discourse and social science inquiry—contributing a nuanced understanding of reform from the practitioners' perspective.

While prior studies on Malaysian science education have examined students' performance and curriculum design, few have explored the lived experiences and professional challenges of teachers implementing the new SPM Practical Test. This study is novel in foregrounding teachers' voices as central agents in assessment reform, linking their self-efficacy, access to resources, and continuing professional development to the success of inquiry-based science learning. The findings contribute to the social science literature by offering an empirically grounded framework for understanding how policy reforms are interpreted and enacted within complex school ecosystems.

Theoretical Framework

This study is grounded in a combination of theories that illuminate how secondary science teachers engage with the implementation of the SPM Practical Test. The framework integrates Bandura's Self-Efficacy Theory, the Resource-Based View (RBV), Kolb's Experiential Learning Theory, and the Constructivist Learning Theory, providing a multidimensional lens through which to examine teachers' perspectives and actions.

According to Bandura's Self-Efficacy Theory (1997), a teacher's belief in their ability to organize and execute specific tasks directly influences their performance and willingness to adapt to new instructional demands. In this study, self-efficacy informs how confident science teachers feel in implementing the practical components of the SPM assessment—particularly in terms of facilitating student-centered experimentation, managing safety, and assessing practical competencies (Zhou et al., 2023).

Complementing this psychological perspective, the Resource-Based View (RBV) (Barney, 1991) emphasizes the strategic role of institutional resources—both tangible (laboratory infrastructure, materials, tools) and intangible (teacher expertise, support systems)—in shaping organizational capabilities. Within the school context, the availability and quality of laboratory resources are critical enablers or barriers to teachers' practical science instruction (Sivalingam, 2024).

The framework also incorporates Kolb's Experiential Learning Theory (1984), which posits that learning is most effective when it is experiential, involving concrete experience, reflective observation, abstract conceptualization, and active experimentation. Teachers' engagement with professional development—especially hands-on training and workshops—affects their ability to internalize and apply practical science pedagogy (Padrón et al., 2024).

Finally, the Constructivist Learning Theory (Vygotsky, 1978) underpins the philosophical orientation of the SPM Practical Test itself, which aims to shift science education from rote learning toward active, student-centered inquiry. Constructivism supports the view that science understanding is constructed through engagement with materials, peers, and guided facilitation (Ismail & Jusoh, 2021).

These theoretical perspectives are woven into a conceptual framework (see Figure 1) that outlines the mediating role of resource access, self-efficacy, and professional development in shaping teachers' practical assessment practices. The framework posits that the quality of

implementation influences not only teacher practices but also student engagement and learning outcomes. By situating the study within this integrated theoretical foundation, the research offers a nuanced understanding of both individual and systemic factors affecting assessment reform in Malaysian secondary schools.

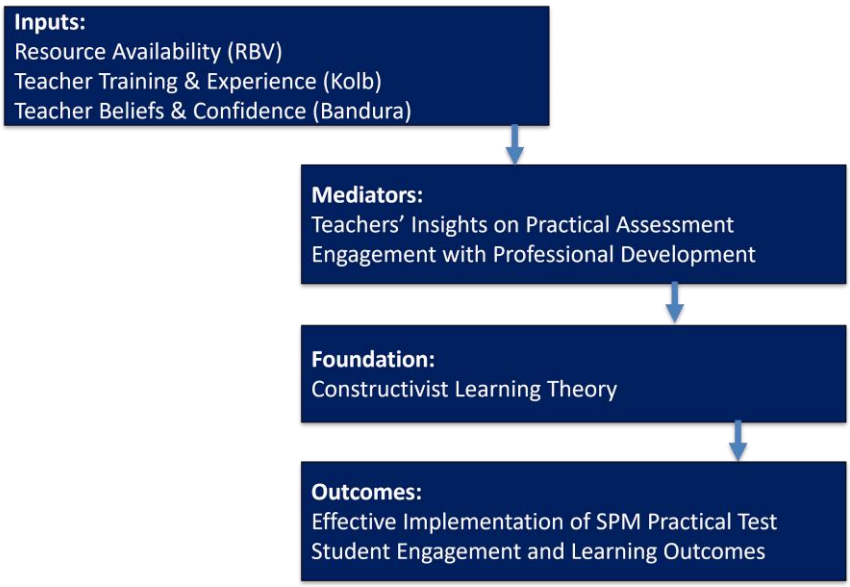

Figure 1. Conceptual framework for practical assessment implementation among secondary school science teachers.

Research Design

This study adopted a qualitative case study design to examine science teachers' insights and challenges related to the implementation of the SPM Practical Test in Malaysian secondary schools. The qualitative approach was deemed appropriate, as it enables a rich, in-depth exploration of participants' lived experiences and contextualized perspectives within their natural settings. According to Yin (2009), a case study is "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." This methodology is particularly suitable for examining the multifaceted nature of educational reforms and implementation practices. The case study approach is especially relevant in educational research where the objective is to understand the dynamics and complexities within specific institutional settings (Stake, 1995). In this study, a bounded case involving six science teachers from government secondary schools in Kuala Langat, Selangor was examined to uncover the nuanced factors influencing the enactment of practical science assessments in Malaysian classrooms.

Research Methodology

To gather rich, qualitative data, semi-structured interviews were conducted with selected science teachers. Semi-structured interviews are advantageous in qualitative research as they provide a balance between the flexibility of open-ended questions and the consistency of a structured interview guide (Kallio et al., 2016). This method allows researchers to delve deeper into participants' responses, facilitating a more comprehensive understanding of their experiences and viewpoints.

During the interviews, participants were encouraged to express their thoughts freely, and the interviewer probed for elaboration when necessary. This approach aligns with the recommendations of Fylan (2005), who emphasizes the importance of creating a conversational environment that encourages participants to share detailed narratives.
Interviews were conducted in languages comfortable to the participants to ensure clarity and ease of expression. Each session lasted approximately 15 minutes, providing sufficient time to explore the key themes related to the research objectives.

Research Instruments
The primary data collection instrument in this study was a semi-structured interview protocol, developed in alignment with the research objectives. The interview guide comprised open-ended questions aimed at eliciting rich, reflective responses concerning teachers' experiences with the SPM Practical Test, their perceptions of student readiness, and the implementation challenges encountered in classroom settings.

The construction of the interview guide followed the systematic framework proposed by Kallio et al. (2016), which emphasizes methodological rigor in qualitative instrument design. This process involved several stages: first, establishing the appropriateness of using semi-structured interviews as a data collection method for the research aims; second, conducting a comprehensive review of relevant literature to inform item construction; third, formulating a preliminary version of the interview questions; and fourth, pilot testing the guide to ensure clarity, flow, and relevance. Based on the pilot outcomes, minor revisions were made before finalizing the instrument. This structured development process enhanced the reliability and validity of the interview protocol, ensuring that it was both theoretically grounded and contextually appropriate for capturing the lived experiences of Malaysian secondary school science teachers.

Sampling Technique
This study adopted a purposive sampling strategy to identify participants with direct and relevant experience in implementing the SPM Practical Test. Purposive sampling, a non-probability method, was selected to ensure that the participants—science teachers actively involved in administering the practical assessment—could provide in-depth, contextually grounded insights (Palinkas et al., 2015). A total of six secondary school science teachers from different school categories in Selangor were interviewed. While this sample size may appear modest, it is consistent with qualitative research standards, particularly in case study designs, where the goal is depth rather than breadth (Yin, 2009). Sampling continued until thematic saturation was achieved—meaning no new themes were emerging from the data, indicating adequacy of the sample for the research objectives (Guest, Bunce, & Johnson, 2006). The sample included teachers from urban, rural, and suburban school settings, ensuring diversity in experience and enabling the identification of cross-contextual implementation challenges.

Data Analysis
The semi-structured interview data were analyzed using thematic analysis (Braun & Clarke, 2006), which offers flexibility in examining teachers' perceptions and contextual factors related to the SPM Practical Test. An inductive approach guided the analysis, allowing themes to emerge directly from the data. All interviews were transcribed verbatim, manually coded, and categorized into themes following Braun and Clarke's six-phase framework. To ensure

trustworthiness, peer debriefing, reflexive journaling, and codebook validation were employed. Coding discrepancies were resolved collaboratively, and an audit trail maintained transparency. This systematic process enabled a credible and rigorous interpretation of teachers' experiences in implementing practical assessments.

Triangulation of Data

To enhance the credibility and trustworthiness of the study, methodological triangulation was employed. According to Denzin (1978), triangulation involves using multiple data sources or methods to examine a phenomenon from different perspectives, thereby strengthening the reliability of findings. In this study, data from semi-structured interviews were triangulated with policy documents (e.g., Ministry of Education circulars, SPM Science Practical Test guidelines), school-level reports on laboratory readiness, and relevant literature on science assessment reforms. These sources corroborated teacher accounts and highlighted convergences and discrepancies between policy and practice. This approach minimized single-source bias and enriched interpretive depth, contributing to the confirmability and dependability of the findings (Lincoln & Guba, 1985). Reflexive memo writing was also maintained to monitor researcher assumptions and ensure interpretations remained grounded in the data.

Table 1
Demographic of respondents

Respondent	Teaching Experience	Subject(s) Taught	Current Form (s)	School Type	Gender	Role in SPM Practical	CPD on Practical Work
Teacher A	12 years	Chemistry	Form 4 & 5	Urban Cluster School	Female	Lead Invigilator	No formal CPD
Teacher B	14 years	Biology, Science	Form 5	Rural School	Female	Practical Supervisor	1 workshop in 2023
Teacher C	5 years	Physics	Form 4	Suburban School	Male	Lab Coordinator	None reported
Teacher D	10 years	Science	Form 3 & 4	Suburban School	Female	Practical Observer	In-house training only
Teacher E	8 years	Biology	Form 4	Rural School	Female	Practical Cosupervisor	1 MOE webinar in 2022
Teacher F	6 years	Chemistry, Science	Form 5	Urban Public School	Male	Practical Supervisor	No CPD since graduation

Across contexts, teachers observed that while students grasped theoretical scientific concepts, many lacked the confidence and autonomy to perform experiments independently. This was most apparent in tasks involving apparatus setup, measurement accuracy, and procedural decision-making. Teachers A, B, D, and F noted that students hesitated to act without explicit guidance, revealing a persistent dependency pattern.

Teachers B and D, both from rural and suburban schools with limited laboratory exposure, reported greater levels of student hesitation and reliance on instruction. Even Teacher A, from a well-equipped urban school, found that students were "too used to passive learning," suggesting that confidence gaps are not merely resource-driven but also rooted in teaching culture and frequency of authentic lab exposure. Teacher F's observations further indicate that teacher experience and repeated engagement in laboratory work can gradually strengthen students' readiness and initiative.

These findings echo those of Rogan and Grayson (2003), who highlighted that students in exam-oriented systems rarely internalize practical competencies without sustained hands-on practice. Similarly, Lee and Fraser (2001) found that teacher-dominated labs diminish students' confidence and ownership, while Halim and Meerah (2010) noted that Malaysian practical work often prioritizes procedural recall over inquiry.

By situating these patterns within the context of the SPM Practical Test implementation, this study provides fresh evidence that student confidence in practical science depends not only on resources but equally on pedagogical design, institutional culture, and exposure continuity. These insights reinforce the urgency of embedding student-centred, inquiry-oriented lab experiences in Malaysia's science education reform.

Student Ability to Conduct Practical Tests

Teachers consistently observed that while students demonstrated a solid grasp of theoretical concepts, many lacked the confidence and procedural fluency required for independent laboratory work. Teachers A, B, D, and F noted that students hesitated when performing tasks such as setting up apparatus or measuring reagents accurately. As one teacher remarked, "They know what the experiment is about, but when they have to do it on their own, they freeze." This issue was more pronounced in rural and suburban schools, where students had fewer opportunities for hands-on laboratory experience before the examination.

Teacher D reported that students appeared anxious and unfamiliar with basic equipment, attributing this to limited lab sessions in earlier schooling. This aligns with Kamarudin et al. (2022) and Othman et al. (2024), who identified persistent gaps between students' theoretical and practical competencies in under-resourced contexts. Similarly, Ismail and Jusoh (2021) found that students' confidence in practical tasks is strongly influenced by the frequency and quality of laboratory exposure.

Further evidence by Zhou et al. (2023) and Padrón et al. (2024) shows that insufficient hands-on experience undermines both skill acquisition and motivation, leading to increased anxiety during practical assessments. The problem is compounded by infrastructure inequities, as highlighted by Sivalingam (2024), which limit laboratory access in rural schools.

School Readiness for Practical Test Implementation

Disparities in school infrastructure and resource availability significantly shaped teachers' readiness to implement the SPM Practical Test. This study found marked differences between urban cluster schools and their rural and suburban counterparts. Teachers from well-resourced schools (e.g., Teachers A and C) reported access to equipped laboratories, sufficient consumables, and reliable technical support—factors that enhanced confidence

and efficiency in conducting practical assessments. In contrast, teachers from less advantaged schools (e.g., Teachers B, E, and F) described persistent shortages of apparatus, outdated equipment, and minimal technician assistance. As Teacher E explained, "Sometimes we have to skip parts of the experiment because we simply don't have the tools."

These findings align with Sivalingam (2024), who noted that rural schools often face underfunded science labs and inadequate maintenance, limiting equitable learning opportunities. Similarly, Tan and Wong (2020) and Hashim and Yusof (2022) reported that rural teachers frequently modify experiments due to logistical constraints, thereby reducing students' hands-on engagement.

Beyond physical resources, school leadership and organizational culture also influenced implementation. In urban schools, administrators were more proactive in supporting teachers through scheduling flexibility and material procurement (Shanmugam & Yamat, 2021), whereas rural teachers often worked independently with limited institutional backing.

Consistent with global evidence (Tondeur et al., 2022; Abdullah et al., 2023), this study underscores that inadequate infrastructure not only hampers instructional quality but also exacerbates educational inequality. Without targeted investment and equitable resource allocation, efforts to standardize science practical assessments risk reinforcing existing urban–rural disparities.

Teachers' Knowledge, Skills, and Self-Efficacy

The implementation of the SPM Practical Test underscores the pivotal role of teachers' knowledge, skills, and self-efficacy in ensuring effective science instruction. This study revealed that teachers who had recently participated in continuous professional development (CPD)—notably from Schools A and C—exhibited greater confidence and competence in facilitating student-led experiments. As Teacher C reflected, "The training helped me let go a bit and trust the students more. Before that, I was doing everything for them."

In contrast, teachers with limited CPD exposure (e.g., Schools B and D) relied more on teacher-centred strategies and faced difficulties guiding autonomous student work. This disparity reflects the findings of Zhou et al. (2023) and Baysal and Mutlu (2021), whose meta-analyses confirmed that targeted PD programs significantly enhance STEM teachers' self-efficacy and instructional practices—especially when they involve inquiry-based, active learning, and collaborative approaches. Similarly, Kelley et al. (2020) reported that participation in integrated STEM PD improved teachers' confidence in implementing interdisciplinary and student-centred learning.

Furthermore, Toma et al. (2024) emphasized that effective science PD must develop both procedural and epistemological understanding to strengthen teachers' self-efficacy in fostering inquiry-based reasoning. Consistent with Birdon (2023), the present study affirms that teachers with higher self-efficacy adopt more flexible strategies, promote engagement, and create environments conducive to scientific inquiry.

Challenges Encountered During Practical Tests

The implementation of the SPM Practical Test has revealed several logistical and pedagogical challenges that hinder effective science instruction in Malaysian secondary schools. These challenges are multifaceted, encompassing time constraints, resource limitations, student anxiety, and safety concerns.

Time Constraints and Resource Limitations

Time constraints emerged as a significant barrier across all participating schools. Teachers A, B, D, and E reported difficulties in completing experiments within the allocated periods, primarily due to large class sizes and time-intensive setup procedures. Teacher B noted, "With 35 students and only a few sets of equipment, it's hard to give everyone hands-on time." This issue is exacerbated in schools with limited laboratory resources, where outdated or insufficient equipment hampers the execution of practical activities. Such resource disparities are consistent with findings by Riduan and Othman (2024), who highlighted inadequate teaching equipment and facilities as significant barriers to comprehensive STEM implementation in Malaysian secondary schools.

Student Anxiety and Confidence

Student anxiety was another prevalent concern, particularly in rural settings. Teachers D and F observed that students displayed visible nervousness during assessments, often leading to mistakes or hesitancy. This phenomenon aligns with the observations of Abdullah and Surat (2019), who identified that students in rural areas often lack confidence in conducting experiments due to limited exposure and practice. The lack of familiarity with laboratory procedures contributes to increased anxiety, which in turn affects performance during practical tests.

Safety Concerns and Pedagogical Adjustments

Safety concerns also influenced the degree of student autonomy during experiments. In under-resourced schools, teachers expressed apprehension about potential accidents, leading them to limit hands-on activities. Teacher E admitted, "I often just demonstrate instead of letting them try, because I'm worried something might go wrong." This cautious approach, while understandable, restricts students' experiential learning opportunities. The study by Belalang and Abd Rahman (2016) supports this finding, indicating that inadequate school facilities and safety equipment often compel teachers to adopt more controlled, demonstration-based teaching methods, thereby limiting student engagement in practical tasks.

Implications for STEM Education

These challenges underscore the need for systemic interventions to enhance the effectiveness of practical science assessments. Addressing time constraints may involve restructuring class schedules to allow longer periods for laboratory work or reducing student-to-equipment ratios. Improving resource availability requires targeted investments in laboratory infrastructure, particularly in rural and underfunded schools. To mitigate student anxiety, schools could implement preparatory sessions that familiarize students with laboratory procedures and equipment. Ensuring safety necessitates not only adequate facilities but also comprehensive training for teachers in laboratory management and emergency protocols.

Conclusion and Implications

This study revealed new insights into how Malaysian secondary science teachers navigate the recent SPM Practical Test reform, a relatively underexplored area in the national assessment discourse. Unlike previous studies focusing mainly on policy design or student performance, this research foregrounds teachers' lived experiences—linking classroom realities, laboratory readiness, and professional development to assessment practice.

The findings highlight that teaching experience alone does not ensure effective practical implementation; rather, success hinges on sustained CPD and systemic support. Limited training opportunities and resource disparities, especially in rural and suburban schools, emerged as critical constraints. By unpacking these contextual complexities, the study offers a novel, teacher-centred perspective on how assessment reforms operate in practice. Strengthening teacher agency through continuous learning, equitable resource allocation, and collaborative professional networks is thus essential for advancing authentic, inquiry-based science education in Malaysia.

Recommendations for Policy and Practice

To strengthen the implementation of the SPM Practical Test, policymakers should prioritize continuous professional development (CPD) focused on inquiry-based assessment and laboratory management. Schools, particularly in rural and suburban areas, require equitable allocation of laboratory resources and structured mentoring support. Collaborative teacher networks and reflective practice communities should be institutionalized to sustain pedagogical innovation. Finally, assessment reforms must be accompanied by ongoing monitoring and feedback mechanisms to ensure alignment between policy intentions and classroom realities.

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AI declaration

The authors affirm that no generative artificial intelligence (AI) tools were used in the creation of the research data, analysis, or interpretation of results. AI-assisted tools (specifically ChatGPT, OpenAI, GPT-5) were used solely to improve the clarity, coherence, and grammar of the manuscript text. The authors take full responsibility for the content and integrity of the work.

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