



e-ISSN: 2600-7568

Available online at
<https://gadingssuitm.com/index.php/gadingss>

**GADING Journal for
the Social Sciences**

GADING Journal for the Social Sciences 29(2) 2026, 223 – 235

Managing and Implementing Laboratory-Based Activities: Challenges and Strategies among Science Teachers

Wan Suriati Wan Asri¹, Nursyahirah Nordin², Siti Nabila Rosle³,
Amalia Qistina Castaneda Abullah⁴, Nur Jannah Azman^{5*}

^{1,2,3}*Faculty of Education, Universiti Teknologi MARA Cawangan Selangor, 42300, Puncak Alam, Selangor, Malaysia.*

⁴*Academy of Language Studies, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000, Kuala Pilah, Negeri Sembilan, Malaysia.*

^{5*}*Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000, Kuala Pilah, Negeri Sembilan, Malaysia.*

ARTICLE INFO

Article history:

Received 17 March 2026
Revised 23 July 2026
Accepted 25 August 2026
Online first 10 September 2026
Published 31 October 2026

Keywords:

laboratory-based activities
science education
science teachers
safety compliance

DOI:

<https://doi.org/10.24191/gading.v29i2.849>

ABSTRACT

This study investigates effective measures to address challenges in managing and implementing laboratory-based activities and examines the status of science teachers. Utilising a mixed-methods research design, the study explores the specific challenges and strategies encountered by science teachers in laboratory management. Data collection involved distributing questionnaires with open-ended questions to science teachers, allowing them to articulate their experiences and approaches. This method captures a wide range of viewpoints and offers deeper insights into the challenges they encounter within the laboratory environment. Key findings emphasise the critical importance of meticulous planning, effective management practices, and proactive engagement in overcoming challenges inherent in laboratory-based science education. The study identifies persistent, multifaceted challenges in laboratory management, including resource inequities such as inadequate infrastructure and outdated equipment in schools, which restrict the experimental scope and diminish learning opportunities for students. Safety compliance emerges as a paramount concern, with risks heightened by inadequate teacher training and support for maintaining stringent safety standards. Furthermore, the absence of external support, such as trained laboratory assistants and sufficient time for personalised student guidance, exacerbates these challenges. Addressing these issues is crucial to ensuring safe and enriching laboratory experiences that enhance student engagement and promote effective learning in science education.

1. INTRODUCTION

Science is the methodical development, analysis, modeling, and observation of patterns found in the physical universe (Mickens, 2016). The fundamental procedures of scientific investigation are covered in science, and practical aspects and related activities must be emphasised to provide students with an understanding of these procedures as well as their identification with experimentation and discovery. Students who study science acquire a wide range of knowledge, including an awareness of natural events

^{5*} Corresponding author. Nur Jannah Azman. E-mail address: nurjannah@uitm.edu.my

and the capacity to conduct experiments in scientific labs. This practical method allows students to explore and learn scientific concepts, promoting a deeper understanding of the natural world and its workings. Science lab experiments enhance students' ability to think critically; rather than merely learning facts, students are encouraged to apply critical thinking skills and comprehend the underlying principles of their observations. This approach fosters a greater understanding of their environment and the natural world. Through science lab experiments, students can pose questions, seek answers, conduct research, and gather information, thus participating in the inquiry component of learning science (Gericke et al., 2023).

Many teachers have expressed dissatisfaction with the quantity of tables, safety of the equipment, storage space for the equipment, and other aspects of the lab environment. Large class sizes, a lack of time and lab space, and the absence of designated timetable periods for practical sessions have prevented most teachers from conducting experiments (Awan, 2015). The goal of scientific education in secondary schools is to develop students' cognitive, technical, and affective science skills through an inquiry-based learning process. One could argue that science-related courses merely provide students access to labs. In science classes, laboratory exercises are essential to give students first-hand experience, provide tangible forms to abstract ideas, and engage students' five senses. Studies have shown that science teachers encounter several challenges when implementing these activities (Akuma & Callaghan, 2020).

The purpose of this study is to investigate the most effective ways to address the issues surrounding the administration and execution of laboratory-based activities as well as the status of science teachers. Currently, nothing has changed to address the ongoing issues in the science lab. The problems in the science lab appear to be persistent and have not been resolved despite previous attempts. To find a remedy, it is critical to identify the underlying causes of these problems and take appropriate action. Teachers often lack the necessary skills to oversee laboratory-based activities effectively due to their limited experience in problem-solving. Consequently, many labs are unavailable, and no experiments are conducted in the classroom. Due to limited laboratory access, students can only perform a restricted variety of experiments. Furthermore, teachers find it challenging to provide students with the attention and support they require due to a lack of resources, time constraints, and a shortage of skilled laboratory assistants (Remperas et al., 2025). Additionally, in today's educational environment, students' attention issues and performance during experiments are becoming increasingly concerning. Students face difficulties when working in groups or independently. Communication problems, varying comprehension levels, and a lack of support from peers during experimentation can create challenges for students working alone or in groups (Brown, 1992; Doncillo & Justo, 2025).

Science teachers in several schools face significant challenges in effectively managing and implementing laboratory-based activities (Chala, 2019). These challenges include security risks, inadequate resources, outdated equipment, and insufficient assistance. Recent research indicates that these challenges are prevalent. A survey conducted by Brown & Green (2019) emphasised that over 50% of schools lack the necessary equipment for effectively conducting basic scientific experiments. The issue is that many schools do not provide safe, well-resourced, and effectively managed laboratory experiences for students. This is a significant concern because laboratory activities are crucial for understanding scientific concepts. When these activities are poorly managed, students' learning and safety are at risk. While we know that safety incidents and resource shortages are common, we still lack sufficient knowledge about specific strategies that can effectively address these challenges. Ideally, school labs should be secure, well-stocked, and operated by qualified personnel who can conduct effective scientific research. Through practical exercises, students should be able to learn without worrying about their safety. However, many school labs do not meet these requirements. Due to a lack of resources, outdated tools, and inadequate training, teachers often struggle to provide students with the best possible learning experiences.

This work is significant because it aims to close this gap by offering practical suggestions grounded in empirical research and real-world experiences. By addressing these issues, we can ensure student safety, increase interest in STEM subjects, and enhance the quality of science education. The goal of this research is to assist educational institutions in providing their students with the best laboratory experiences possible, ensuring that experiential learning is secure, efficient, and engaging (Aidman & Baray, 2016).

2. LITERATURE REVIEW

Effective scientific education must include practical and hands-on laboratory exercises. However, planning and carrying out these activities constantly presents a variety of difficulties for scientific instructors. The general lack of infrastructure and necessary resources is one of the main challenges in science education. According to Kamba et al. (2019), a lack of science teaching resources in many schools directly impedes efficient instruction and learning. Budget constraints exacerbate this problem by making it challenging for educational institutions to maintain, improve, or purchase the supplies and equipment required for practical experiments (Ayoko et al., 2023; Bocskor et al., 2017). Additionally, Zenda (2024) noted that the overall quality of science instruction is seriously compromised when old equipment and scarce resources are used. Teachers and students become demotivated when laboratory facilities are lacking or inadequate, which forces training to shift toward abstract thinking with little experimentation (Hodson, 1993).

Another significant challenge for science teachers is controlling student conduct while keeping a secure learning environment. Because science labs are dynamic and potentially dangerous, teachers must always be on guard to avoid mishaps while trying to keep students interested (Bocskor et al., 2017). A lab's hectic, interactive environment sometimes results in diversions and possible safety infractions. In overcrowded classrooms with insufficient support staff and pupils who are not familiar with basic safety procedures, these hazards are further increased (Tadesse, 2026).

There are many pedagogical and practical difficulties with incorporating laboratory work into the larger educational system. Rigid curricula and stringent administrative regulations frequently place restrictions on teachers (Johnson, 2020). It takes a high degree of pedagogical expertise and subject mastery to design experiments that both meet rigorous curriculum standards and pique students' interest (Pate & McKendree, 2015; Morris, 2025). Additionally, teachers find it difficult to find time to plan, carry out, and evaluate lab sessions due to their hectic schedules covering a large amount of syllabus content. This problem is exacerbated by the demanding workload of pre-lab preparation and post-lab cleanup (Ndiokubwayo, 2017).

These operational challenges are made worse by a lack of professional growth and specialised training. In terms of safety procedures, equipment upkeep, and inquiry-based teaching approaches, many educators claim to be ill-equipped to oversee laboratory settings successfully (da Silva, 2023). Teachers find it difficult to stay current on best practices and cutting-edge scientific teaching techniques without ongoing training opportunities and institutional support (Bocskor et al., 2017).

In conclusion, teachers must overcome significant obstacles, such as a lack of resources, safety hazards, time limits, and inadequate training, even though hands-on laboratory experiences are essential for science education. To advance science teaching, it is essential to address these interrelated concerns through targeted funding, improved facilities management, ongoing professional development, and administrative assistance.

3. METHOD

The purpose of this study is to investigate the strategies used and challenges faced by teachers in the Pasir Puteh and Shah Alam areas when supervising and conducting laboratory-based activities. Pasir Puteh and Shah Alam were chosen as study locations due to their accessibility and contextual relevance; Pasir Puteh is the researcher's hometown, which facilitates data collection, and the researcher completed a practical teaching internship at a school in Shah Alam. Additionally, by including these two different sites, results from communities with varying socio-educational backgrounds can be compared. Determining the size of a focus group for qualitative research can be challenging, as it relies on data saturation rather than statistical power. Guest et al. (2017) suggest that data saturation can typically be achieved with a focus group consisting of 6-10 participants. As a result, this study involved a sample size of 30 secondary school science teachers from the Pasir Puteh and Shah Alam areas.

The difficulties and strategies experienced by science teachers in overseeing and conducting laboratory-based activities are examined in this study using a mixed-method research design. The study utilises questionnaires to gather the necessary data, which are then disseminated online. Teachers in the scientific sector are given surveys with open-ended questions that allow them to describe their experiences, challenges, and approaches in their own words. The survey items were carefully examined and selected based on their suitability for the teaching and learning approaches implemented in the selected schools (Balci, 2007; Baskaran et al., 2024). This method helps to capture a variety of perspectives and provides a deeper understanding of the difficulties they face in the lab setting.

Science teachers in secondary schools in the Pasir Puteh and Shah Alam areas, who teach physics, biology, and chemistry, are the target demographic for this study. The sample was purposively chosen based on their interest in participating in the research. Teachers' collaboration and voluntary responses are essential for obtaining relevant and trustworthy data in any qualitative study methodology. An online questionnaire is the method used to collect data. Using Google Forms, a practical and widely available tool, the survey was sent to science teachers. The open-ended questions on the surveys allow science teachers to describe their experiences, challenges, and strategies in their own words. This method is effective for gathering qualitative and in-depth information from multiple respondents.

Using random selection procedures, science teachers were given online questionnaires through Google Forms. Teachers can complete the questionnaire at their own pace, which leads to thoughtful and thorough responses.

The survey consists of eight questions. Based on the responses, this method aims to assess the difficulties and strategies science teachers encounter when managing and carrying out laboratory-based activities. Part of the data analysis process for this study involved a thorough examination of the survey data. The findings from the Google Forms survey were first organised and analysed to identify recurring themes and patterns. Each response was carefully examined to understand the experiences and challenges faced by science teachers when supervising and conducting laboratory-based activities. Notable details and recurring themes were noted, making it easier to group the data into relevant categories.

4. FINDING & DISCUSSION

4.1 Demographic Profile

The distribution of science teachers by age group is shown in Table 1. 40% of the sample is made up of teachers who are primarily between the ages of 25 and 35. Teachers between the ages of 36 and 45 make up 36.7% of the sample, while teachers between the ages of 46 and 55 make up 20%. Teachers between the ages of 56 and 60 make up the smallest percentage of the sample, accounting for 3.3%. This age distribution shows that the participating teachers represent a range of age groups, which could have an impact on the viewpoints and experiences they provided for the study.

Table 1. Teacher Distribution Based on Age

Age	Frequency	Percentage (%)
25-35 years old	12	40.0
36-45 years old	11	36.7
46-55 years old	6	20.0
56-60 years old	1	3.30

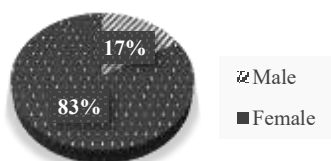


Fig. 1. Teacher distribution based on gender

The gender distribution of science teachers is displayed in Figure 1. Five (16.7%) of the 30 participants are men, and 25 (83.3%) are women. This suggests an imbalanced gender distribution in the sample, with a large majority of female participants relative to male participants. When examining these teachers' comments, it is crucial to consider the numerical discrepancy because it could have an impact on the viewpoints and insights that were expressed throughout the study.

According to Figure 2, most of the science teachers —17 out of 30 (56.7%)—teach general science. Twelve out of thirty teachers (40%) teach physics, making it the second most popular subject. Five out of thirty teachers (16.7%) teach chemistry, while four out of thirty teachers (13.3%) teach biology.

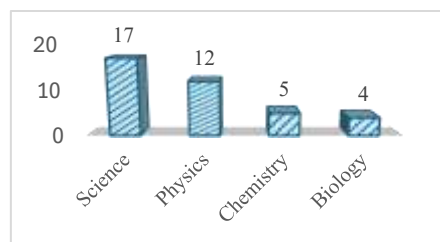


Fig. 2. Teacher distribution based on subjects

Referring to Figure 3, 70 % of schools have suitable laboratory conditions. In the meantime, conditions in 23.3% of the laboratories are subpar. Just 6.7% of labs are in extremely good condition. These findings show that the laboratories in schools are in good enough condition, and it is anticipated that instructors will be able to use these facilities to implement science learning activities that focus on observation and inquiry.

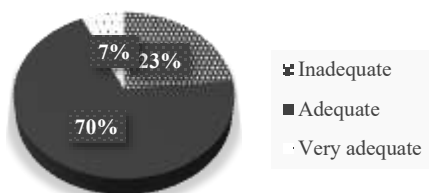


Fig. 3. Condition of laboratory

4.2 Findings of the responses Provided to the Questionnaire

The responses to the question "While doing the activities, what do you need to do to ensure that the experiment goes smoothly?". Below is a summary of the main conclusions drawn from the responses:

(i) *Preparation and Planning*

Teachers are essential in making sure that every student listens while the experimental process is described. Before beginning the experiment, this entails ensuring that students are aware of and comprehend the process.

(ii) *Clear Communication*

One of the main duties teachers is to allot time for explaining the experiment's goal, methodology, and any safety measures. To provide students a basic understanding of the process, this may entail providing a quick explanation one class before to the experiment.

(iii) *Student Engagement and Supervision*

One of the most important strategies teachers uses is to make sure that students are placed in groups of varying levels and to explicitly assign work to those groups. This facilitates classroom management and guarantees that every student is participating. Throughout the experiment, teachers must also keep an eye on how the students behave and make sure the instructional materials hold their interest.

(iv) *Safety and Resources*

A common theme is making sure that all required supplies and tools are on hand and adequate before the experiment starts. This planning facilitates a seamless and interruption-free trial. Teachers also emphasised the significance of providing clear instructions to prevent injuries and urged students to be ready by knowing about the experiment in advance.

(v) *Time Management*

For the experiment to go smoothly, it is crucial that students follow directions and arrive on time. Teachers must efficiently schedule the experimental period and ensure adequate preparation prior to the experiment. In summary, the responses show that the teacher's responsibility in ensuring the successful completion of laboratory tasks involves careful planning, effective communication, active monitoring, and adequate resources. These results highlight the significance of careful preparation, efficient administration, and proactive participation in overcoming the difficulties related to laboratory-based science instruction. According to the respondents' thoughts, teachers play a variety of roles in helping students have safe and productive laboratory experiences, which are crucial for encouraging scientific curiosity and helping them improve their critical thinking and problem-solving abilities.

4.3 Findings of the responses Provided to the Questionnaire

"What are the problems that you face in the laboratory?" was the next question posed to scientific teachers working in schools. Three categories were created from the responses after the data analysis. Table 2 provides a summary of these groups.

Table 2. Problems faced in the laboratory

Categories	Sub categories	Frequency
Context-caused problems (Classroom/School/ Laboratory)	Inadequate materials.	18
	Laboratories being useless.	4
	No laboratories available/experiment conducted in classes	5
	The number of the science and technology teachers	18
	Crowded classes.	8
Teacher-related problems	Not preparing the laboratory to conduct the experiments.	5
	Lack of time.	18
	Students' attention problems.	14
	Difficult classroom management in the laboratory.	6
	Students motivation decreases when the experiments fail	9
	Lack of time allocated to the experiments	22

Students-related problems	Students not taking the experiments and laboratory activities seriously.	19
	Students not paying attention to the results of the experiments.	16
	Students having problems while working individually or in groups.	11
	Students not knowing how to behave in a laboratory.	3
	Students not taking the lessons conducted in the laboratory seriously.	12
	Students considering the activities as entertaining.	10
	Students' coming to the lab without getting prepared.	20
	Students' making noise in the laboratory.	10

(i) *Context-Caused Problems*

Lack of appropriate materials was the most cited context-caused issue (18 responses), which seriously impairs teachers' capacity to carry out successful laboratory exercises. The problem of not having enough science and technology teachers (18 replies) came in second, which adds to the workload and limits the amount of time teachers can spend planning and directing experiments. Effective laboratory work is significantly hampered by the existing laboratories' lack of utility, which is stated less frequently (4 responses).

(ii) *Teacher-Related Problems*

Among teacher-related difficulties, the most common issue was the lack of time devoted to experiments (22 replies). This is indicative of a larger issue with the curriculum, which is that there is not enough time for practical exercises. Significant problems included teachers' lack of preparation (5 responses) and challenging classroom management (6 responses), suggesting that some teachers find it challenging to properly arrange and manage the lab setting.

(iii) *Student-Related Problems*

According to the responses, the most common student-related issue is when students arrive at the lab unprepared (20 responses). The efficiency and flow of lab sessions are impacted by this lack of planning. The problem of students not taking laboratory exercises seriously (19 answers) is closely related and compromises the learning goals of these exercises. Three replies about students not knowing how to act in a lab further highlight the variety of behavioural and motivational issues teachers face.

According to the questionnaire's results, science teachers encounter a variety of difficulties in the lab. The most common ones include students' lack of preparation and seriousness about laboratory activities, inadequate materials, and a lack of time for experiments. Together, these problems make it difficult to successfully execute laboratory-based science instruction, highlighting the need for improved materials, more time allotted in the curriculum, and techniques to enhance student conduct and involvement in the lab.

With respect to student-related problems, students in both locations may face difficulties in connecting experimental activities with underlying scientific concepts, as noted by Abrahams and Millar (2008). However, differences may emerge in terms of engagement and prior exposure, where students in Shah Alam might demonstrate higher familiarity with laboratory environments, while students in Pasir Puteh may require more guidance and scaffolding during laboratory activities. The outcomes are also in line with Hofstein and Lunetta's (2004) findings, which show that while laboratory exercises are generally accepted as essential to science education, their efficacy is frequently constrained by elements pertaining to student engagement, teacher practices, and contextual limitations.

4.4 Subject That Have Difficulty/Unwilling to Conduct Activities

One of the questionnaire's questions sought to determine which subjects' teachers find challenging or are reluctant to teach. The following table summarises the frequency and proportion of teachers who reported difficulty or unwillingness for each topic after the responses were examined and grouped by subject:

Table 3. Subject that has difficulty/unwilling to conduct activities

Subject that has difficulty/unwilling to conduct activities	Frequency	Percentage (%)
Physics	8	26.7
Biology	7	23.3
Chemistry	12	40.0
Science	3	10.0

Significant differences in the difficulty or reluctance to do tasks across several science areas are revealed by the data. With 12 respondents (40%) reporting difficulties, chemistry is the topic with the most reported difficulty or unwillingness to carry out activities. This high number indicates that conducting chemical activities presents significant challenges for many teachers.

With eight teachers (26.7%) expressing difficulty or reluctance, physics is similarly seen as a difficult subject. The abstract character of many ideas, the requirement for specialised tools, or the difficulty of illustrating physical concepts in a classroom context can all be contributing factors to physics' difficulties (Cox & Junkin, 2002).

Additionally, one of the questionnaire's questions asked teachers which subjects they found challenging or in which they were reluctant to do activities, as well as the reasons behind these difficulties. The answers highlight a range of problems that science teachers encounter when leading lab exercises.

4.4.1 Subjects of Difficulty and Unwillingness

Many respondents found chemistry to be a particularly challenging subject for conducting experiments, offering several explanations for this difficulty. First, troublesome student behavior was a frequent concern; students often played and handled chemicals carelessly, which compromised their safety. Due to their complexity and inherent hazards, chemicals require careful handling and strict adherence to safety protocols.

Another major constraint was time. Chemistry experiments are often time-consuming and slow to produce results, which ultimately hinders syllabus coverage and the ability to achieve accurate outcomes. Additionally, the difficulty of sourcing and preserving perishable, safe supplies further compromised experimental quality. Respondents also noted challenges in data collection, which were compounded by the fact that experimental outcomes frequently deviated from theoretical predictions, thereby complicating the learning process.

Physics was also found to present substantial difficulties, albeit for different reasons. Both teachers and students found practical physics less engaging, leading to a decline in interest and involvement. Another significant issue highlighted was the lack of adequate equipment and supplies to conduct tests. Similar to chemistry, time constraints were a pervasive problem; physics experiments frequently exceeded the allocated class period, affecting both the execution of the experiment and efficient cleanup management. These difficulties highlight the need for innovative strategies to stimulate student interest and improve resource management in physics instruction (Roth, 1994).

Although biology is not as widely discussed in this context as chemistry and physics, it nonetheless poses significant challenges for educators. Teachers highlighted several subject-specific issues, notably that biology studies frequently require specialised, perishable specimens. Safely acquiring and maintaining these materials requires meticulous preparation. Furthermore, logistical issues arise because the time needed for setup, experimentation, and cleanup often surpasses the time allotted for laboratory sessions.

Additionally, varying levels of student comprehension make the process much more complex, making it difficult to ensure that every student is prepared and capable of conducting experiments safely. These challenges underscore the critical role of strategic planning and resource management in improving biology education outcomes (Tuyishime & Tukahabwa, 2022).

Collectively, these results demonstrate the multifaceted challenges that science teachers encounter when leading laboratory exercises. These obstacles include managing student behavior, maintaining safety, coping with limited time and resources, and addressing diverse student comprehension levels (Hart et al., 2000).

4.5 Findings of the Responses Provided to the Questionnaire

The second section of the questionnaire addressed the following topic: “*What are your strategies to overcome the challenges that occur in the laboratory?*” Teachers were also informed that they could select multiple options. Table 4 summarises the data gathered from this inquiry.

Table 4. Strategies that teachers employ to overcome the challenges

Questions	Frequency
Identify essential materials for upcoming experiments and prioritise them based on their critical role.	12
Plan experiments that fit within the allocated class time.	24
Incorporate interactive elements, such as hands-on demonstrations, simulations, or case studies, to enhance engagement.	21
Clearly communicate the importance of preparation and set expectations for students to arrive with a basic understanding of the experiment.	21

The responses to the questionnaire reveal the specific methods science teachers employ to mitigate laboratory difficulties. A majority of the teachers (24) focus on organising experiments to maximise class time, indicating that time management during lab sessions is a primary consideration. Conversely, fewer educators (12) emphasised the importance of selecting and arranging necessary supplies beforehand. This suggests that while time management is a major concern, some teachers may not place an equal emphasis on material preparation. Overall, these findings provide insight into the diverse strategies teachers use to ensure successful laboratory sessions. Furthermore, an analysis of the questionnaire responses indicated that demographic factors—specifically age and gender—did not have a statistically significant impact on the results. This suggests that the identified challenges and solutions were consistent across all respondent groups.

According to Hofstein and Kind (2012), pre- and post-laboratory discussions can foster deeper conceptual understanding. They also note that teachers' pedagogical skills can be strengthened through ongoing professional development, and that effective laboratory instruction can be enhanced by using guided inquiry approaches rather than entirely open inquiry. Similarly, Abrahams and Reiss (2012) state that the efficacy of practical work can be increased by focusing on the development of conceptual understanding rather than mere procedural completion, encouraging student reflection and discussion following experiments, and clearly structuring activities with explicit learning objectives.

In summary, the results show that teachers utilise several practical techniques to navigate the difficulties of laboratory-based activities. These include the application of guided inquiry techniques, structured pre- and post-laboratory discussions, explicit learning objectives, and continuous professional development. These strategies aim to boost student engagement, deepen conceptual understanding, and improve classroom and laboratory management (Wasitoh et al., 2025). Ultimately, successfully implementing laboratory-based teaching methodologies requires balancing pedagogical knowledge with the unique contextual factors of each educational setting.

5. CONCLUSION

This study provides significant new insights into the challenges faced by science teachers in managing laboratory-based activities, as well as the strategies they employ to overcome them. By examining resource constraints, safety protocols, and professional development needs, this research highlights the multifaceted nature of laboratory administration in science education.

Based on these findings, several recommendations can be made to enhance the management of science laboratories, including enhanced resource allocation, stricter safety regulations, and the promotion of collaborative professional development opportunities for educators. Through these initiatives, stakeholders can create safer, more effective learning environments that boost student interest and instructional efficacy. Additionally, by providing empirical evidence of the need to systematically address these challenges, this work expands upon existing literature and dispels the myth that laboratory management is a rigid or unchanging practice. It is solely about supplies and technology by highlighting the crucial roles that teacher preparation and group planning play in achieving positive educational outcomes. More broadly, this study contributes to global initiatives to improve science teaching practices. By promoting evidence-based practices and tackling real-world issues teachers face, this project will aid in the continuous enhancement of laboratory-based learning opportunities. Our goal is to establish a more equitable and effective learning environment where all students may access successful science instruction under the direction of qualified and empowered teachers.

6. ACKNOWLEDGEMENTS/FUNDING

The authors thank all the participants who take part in the current study and Faculty of Education, UiTM Selangor Branch, Puncak Alam Campus for the support.

7. CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

8. AUTHORS' CONTRIBUTIONS

Wan Suriati Wan Asri and **Nursyahirah Nordin**: data collection and data analysis. **Siti Nabila Rosle**: supervision of research progress. **Nur Jannah Azman**: writing the problem statement and structure of the paper. **Amalia Qistina Castaneda Abullah**: editing and proofreading of the manuscript.

9. DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES

This manuscript was developed with the assistance of Quill Bot for the purpose of refining the sentence structure. The authors assume full responsibility for the final version submitted for publication.

10. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

The datasets used and analysed during the current study are available from are available at: https://docs.google.com/document/d/1e7GT_PQMoq8esmyLZNxX00Fq5gPGV8if/edit?usp=sharing&amid=117909977093774140081&rtopof=true&sd=true

11. ETHICS STATEMENT

This study was reviewed and approved by the Institutional Ethics Committee of UiTM Research Ethics Committee under the approval number ED/REC/F/10827. All procedures involving human participants/animal subjects were in fulfilment of the ethical standards of the 1964 Helsinki Declaration. Informed consent was obtained from all participants, and data anonymity was strictly maintained throughout the study.

12. REFERENCES

- Abrahams, I., & Millar, R. (2008). Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in school science. *International Journal of Science Education*, 30(14), 1945–1969. <https://doi.org/10.1080/09500690701749305>
- Abrahams, I., & Reiss, M. J. (2012). Practical work: Its effectiveness in primary and secondary schools in England. *Journal of Research in Science Teaching*, 49(8), 1035–1055. <https://doi.org/10.1002/tea.21036>
- Aidman, B., & Baray, S. N. (2016). Leveraging community resources: Creating successful partnerships to improve schools. *In The Educational Forum*, 80(3), 264–277. <https://doi.org/10.1080/00131725.2016.1173749>
- Akuma, F. V., & Callaghan, R. (2020). Gaps in teacher competencies linked to inquiry-based practical work in certain resource-constrained South African physical sciences classrooms. *In Journal of Physics: Conference Series* (Vol. 1512, No. 1, p. 012035). IOP Publishing. <https://doi.org/10.1088/1742-6596/1512/1/012035>
- Awan, M. N. (2015). Physical Conditions of Science Laboratories and Problems Faced by Science Teachers in Conducting Practicals in Punjab. *Bulletin of Education and Research*, 37(1), 47–54. [No DOI assigned for this issue; published open-access in journal repository]
- Ayoko, V. O., Peter, T., & Jegede, D. O. (2023). Inadequacy of infrastructural facilities in public universities in Nigeria: Causes, effects and solutions. *International Journal on Integrated Education*, 6(3), 36. <https://doi.org/10.17306/I.INTERCATHEDRA.2021.00115>
- Balcı, A. (2007). Development of a laboratory safety questionnaire for middle school science teachers. *Eurasian Journal of Educational Research*, 28, 1–14.
- Baskaran, V. L., Abdullah, N., & Wong, K. T. (2024). The awareness level among primary school science teachers on the importance of science laboratory management. *International Journal of Academic Research in Business and Social Sciences*, 14(1), 3261–3270. <https://doi.org/10.6007/IJARBS/v14-i1/20658>
- Bocskor, Á., Hunyadi, M., & Vince, D. (2017). National Academies of Sciences, Engineering, and Medicine (2015) The Integration of Immigrants into American Society. Washington, DC: The National Academies Press. Intersections. *East European Journal of Society and Politics*, 3(3). <https://doi.org/10.17356/ieejsp.v3i3.366>
- Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The journal of the learning sciences*, 2(2), 141–178. https://doi.org/10.1207/s15327809jls0202_2
- Brown, A. H., & Green, T. D. (2019). The essentials of instructional design: Connecting fundamental principles with process and practice. *Routledge*. <https://doi.org/10.4324/9780429439698>
- Chala, A. A. (2019). Practice and challenges facing practical work implementation in Natural Science subjects at secondary schools. *Practice*, 10(31), 1–17. <https://doi.org/10.7176/JEP/10-31-01>
- Cox, A. J., & Junkin III, W. F. (2002). Enhanced student learning in the introductory physics laboratory. *Physics Education*, 37(1), 37. <https://doi.org/10.1088/0031-9120/37/1/306>
- da Silva, C. A., Almeida, R. P. P., Abrantes, A. F., Azevedo, K. B., Vicente, B., Carvalheira, F., ... & Mestre, T. (2023). Rethinking the continuous education and training of healthcare professionals in the context of digital technologies. In *Handbook of Research on Instructional Technologies in Health Education and Allied Disciplines* (pp. 105–129). IGI Global Scientific Publishing. <https://doi.org/10.4018/978-1-6684->

- Doncillo, D., & Justo, A. (2025). Pedagogical Skills Through Laboratory-Based Instruction and Its Relations to the Current Status of the Science Laboratory Facilities. *Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields*, 1(7), 8-53. <https://doi.org/10.5281/zenodo.10521893>
- Gericke, N., Högström, P., & Wallin, J. (2023). A systematic review of research on laboratory work in secondary school. *Studies in science education*, 59(2), 245-285. <https://doi.org/10.1080/03057267.2022.2107409>
- Hart, C., Mulhall, P., Berry, A., Loughran, J., & Gunstone, R. (2000). What is the purpose of this experiment? Or can students learn something from doing experiments?. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 37(7), 655-675. [https://doi.org/10.1002/1098-2736\(200009\)37:7](https://doi.org/10.1002/1098-2736(200009)37:7)
- Hodson, D. (1993). Re-thinking old ways: Towards a more critical approach to practical work in school science. <https://doi.org/10.1080/03057269308560022>
- Hofstein, A., & Lunetta, V. N. (2004). The laboratory in science education: Foundations for the twenty-first century. *Science Education*, 88(1), 28–54. <https://doi.org/10.1002/sce.10106>
- Hofstein, A., & Kind, P. M. (2012). Learning in and from science laboratories. In B. J. Fraser, K. G. Tobin, & C. J. McRobbie (Eds.), *Second international handbook of science education* (pp. 189–207). Springer. https://doi.org/10.10007/978-1-4020-9041-7_15
- Johnson, S. M. (2020). Where teachers thrive: Organizing schools for success. *Harvard Education Press*. [ISBN: 978-1682534403]
- Kamba, A. H., Libata, I. A., & Usman, A. (2019). Lack of availability of science teaching facilities on students teaching and learning science in some selected secondary schools in Kebbi State. *Journal of Advances in Education and Philosophy, J Adv Educ Philos*, 3(7), 1. <https://doi.org/10.36348/JAEP.2019.v03i07.001>
- Mickens, R., & Patterson, C. (2016). What is science?. *Georgia Journal of Science*, 74(2), 3. <https://digitalcommons.gaacademy.org/gjs/vol74/iss2/3>
- Morris, D. L. (2025). Rethinking science education practices: Shifting from investigation-centric to comprehensive inquiry-based instruction. *Education Sciences*, 15(1), 73. <https://doi.org/10.3390/educsci15010073>
- Ndihokubwayo, K. (2017). Investigating the Status and Barriers of Science Laboratory Activities in Rwandan Teacher Training Colleges towards Improvisation Practice. *Online Submission*, 4(1), 47-54. <https://doi.org/10.4314/ajesms.v13i1.5>
- Remperas, R. N., Paul, M., & Calzada, T. (2025). Teachers' Challenges and Best Practices on Laboratory Approaches in Science Teaching. *International Journal of Science*, 2(5). <https://doi.org/10.11648/j.ijjsqa.20251101.12>
- Pate, M. L., & McKendree, R. B. (2022). Managing the classroom and laboratory. In *Preparing Agriculture and Agriscience Educators for the Classroom* (pp. 169-185). IGI Global Scientific Publishing. <https://doi.org/10.4018/978-1-6684-4783-3.ch009>
- Roth, W. M. (1994). Experimenting in a constructivist high school physics laboratory. *Journal of Research in Science Teaching*, 31, 197–223. <https://doi.org/10.1002/tea.3660310208>
- Tadesse, H. (2026). Managing Overcrowded Science Classrooms in Addis Ababa: A Phenomenological Study of Teachers' Challenges and Coping Strategies. *Education and Urban Society*, 58(6), 708-732. <https://doi.org/10.1177/00131245251298102>

- Tuyishime, J. P., & Tukahabwa, D. (2022). The Role of Practical Approach on Students' Engagement in Biology: A Case of Lower Secondary Schools in Rulindo District, Rwanda. *East African Journal of Education and Social Sciences*, 3(3), 129-139. <https://doi.org/10.4314/eajess.v3i3.188>
- Wasitoh, E., Ismaya, B., & Suryaman, M. (2025). Science laboratory management and the implications for students' motivation and learning achievement. *Research Horizon*, 5(6), 3233-3244. <https://doi.org/10.54518/rh.5.6.2025.3233-3244>
- Zenda, R. (2024). The importance of teaching resources on physical sciences learners' academic achievement in rural schools: A case of South Africa. *Social Education Research*, 407-420. <https://doi.org/10.37256/ser.5120243407>



© 2026 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY-NC-ND) license (<http://creativecommons.org/licenses/by/4.0/>).

About the Authors

Wan Suriati Wan Asri is a graduate of the Faculty of Education, Universiti Teknologi MARA, Cawangan Selangor, Malaysia. She can be contacted at 2020830762@student.uitm.edu.my.

Nursyahirah Nordin is a graduate of the Faculty of Education, Universiti Teknologi MARA, Cawangan Selangor, Malaysia. She can be contacted at 2025992009@student.uitm.edu.my.

Siti Nabila Rosle is a graduate of the Faculty of Education, Universiti Teknologi MARA, Cawangan Selangor, Malaysia. She can be contacted at nabila@gmail.com).

Amalia Qistina Castaneda Abullah is a Senior Lecturer at the Academy of Language Studies, Universiti Teknologi MARA Cawangan Negeri Sembilan, Malaysia. Her main research interests are in the field of teaching and learning. She can be reached via email at amali608@uitm.edu.my.

Nur Jannah Azman, PhD is a Senior Lecturer at the Faculty of Applied Sciences, Universiti Teknologi MARA Cawangan Negeri Sembilan, Malaysia. She served as the project supervisor for this study. Her main research activities are mainly in the fields of Physics and teaching and learning. She can be contacted at nurjannah@uitm.edu.my.