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THE INFLUENCE OF LABORATORY FACILITIES AND INFRASTRUCTURE AVAILABILITY ON THE QUALITY OF SCIENCE LEARNING: A SYSTEMATIC LITERATURE REVIEW STUDY

Wicha Rosari Damanik[1], Yuneyka Rivera Rajagukguk[2], Tariza Fairuz[3]
[123]Program Studi Biologi, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Medan, Medan, Indonesia
Correspondence Email: wichadamanik@gmail.com

ABSTRACT

This study aims to analyze the influence of laboratory facilities and infrastructure availability on the quality of Natural Science (IPA) learning at the secondary school level. A Systematic Literature Review (SLR) with a descriptive qualitative approach was applied to identify, evaluate, and synthesize relevant research findings from national and international articles published between 2021 and 2025. From 50 articles initially identified, 15 were selected based on inclusion and exclusion criteria and analyzed using meta-synthesis. Results indicate that the availability and standardization of laboratory facilities significantly influence learning effectiveness, science process skills, conceptual understanding, learning motivation, and academic achievement. Well-equipped and well-managed laboratories increase students' active participation in practicum activities, creating more meaningful learning experiences. Conversely, limited facilities, weak management, and low safety compliance lead to theoretical-dominant learning and reduced learning quality. Facility gaps between schools further contribute to inequalities in science education quality. This study concludes that fulfillment, standardization, and systematic management of laboratory facilities and infrastructure are key factors in sustainably improving the quality of science learning.

Keywords: Science Laboratory; Facilities and Infrastructure; Learning Quality; Science Process Skills; Systematic Literature Review.

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INTRODUCTION

Natural Sciences (IPA) occupies a strategic position in elementary and secondary education, with the primary goal not simply to transfer knowledge but also to develop scientific thinking, train observation skills, and foster critical thinking in students. Unlike subjects that are simply presented verbally in the classroom, science requires a dedicated space where students can directly observe, experiment, and prove the concepts they learn. This is where laboratories become indispensable, not merely an addition to the school building, but the heart of true science learning. Numerous studies have confirmed that the quality of science learning depends heavily on how well laboratory facilities are provided and managed (Lestari et al., 2025; Mustika & Hamidah, 2025).

Science laboratories are fundamentally designed as places for students to learn directly, rather than simply absorbing information from textbooks or teacher explanations. In these spaces, students can experience the real-world process of science, from making initial assumptions, making observations, collecting data, to drawing conclusions based on their own findings. This process is far more effective in fostering deep understanding than simply listening to lectures in class. Mustika and Hamidah reinforce this view by demonstrating that the completeness of laboratory facilities significantly contributes to increasing the effectiveness of science learning and students' skills in conducting practicums. To ensure this quality, the government has established minimum standards for science laboratories through Ministerial Regulation No. 24 of 2007 concerning School Facilities and Infrastructure Standards, which requires each laboratory to have a suitable space, sufficient equipment, supporting learning media, and various other supporting facilities to ensure that every practicum activity takes place safely, in a structured manner, and is able to simultaneously touch the cognitive, attitudinal, and skill aspects of students (Mustika & Hamidah, 2025).

Laboratory facilities encompass all equipment and materials directly used during experimental activities, while infrastructure refers to supporting physical aspects such as room conditions, air circulation, electrical installations, chemical storage, and safety systems. The two are inseparable because they both influence the frequency, quality, and motivation of students in practical activities. Research by (Lestari et al., 2025) in several junior high schools revealed a rather alarming picture. Although some schools had facilities above 70 percent of the national standard, there was still a significant gap between actual and ideal conditions. Similar findings were expressed by (Anjiana et al., 2025), who concluded that limited facilities prevented laboratories from being optimally utilized, thus hampering the overall quality of science learning and necessitating the need to improve teacher capacity in laboratory management (Anjiana et al., 2025; Lestari et al., 2025).

The influence of laboratory facilities has also been shown to extend beyond grades and academic achievement. (Ahmed et al., 2025), through a study in Nigerian secondary schools, found that the availability and intensity of laboratory equipment use were directly proportional to students' academic achievement in science. When access to laboratories is limited, the impact is not only felt on test scores, but also weakens learning motivation and creates disparities in the quality of learning experiences between schools, which becomes an issue of educational equality. Moreover, adequate laboratory facilities have been proven to encourage student enthusiasm in practicums, make learning feel more alive, real, and relevant to everyday life, while also supporting the development of higher-order thinking skills that are the orientation of today's science education. However, various obstacles still hinder the provision of laboratory facilities in many schools, including limited funding, minimal policy commitment, negligence in maintenance, and low teacher ability to utilize facilities optimally. Therefore, a structured laboratory management system is needed, starting from planning, procurement, routine maintenance, and periodic evaluation (Ahmed et al., 2025; Anjiana et al., 2025; Lestari et al., 2025).

Several studies have demonstrated a relationship between laboratory facilities and science learning outcomes. However, most studies still focus on the level of facility completeness or learning outcomes in general, without specifically examining the effect of the availability of laboratory facilities and infrastructure on the quality of science learning. This gap indicates the need for research that focuses more on the direct influence of laboratory facility availability on the process and quality of science learning.

Based on this background, this study aims to analyze the influence of the availability of science laboratory facilities and infrastructure on the quality of science learning. Theoretically, this research is expected to enrich the study of the relationship between educational facilities and the effectiveness of science learning. Practically, the results of this study can provide considerations for schools in planning and managing science laboratories for optimal results.

Previous research has shown a relationship between laboratory facilities and science learning outcomes. However, most of these studies have focused on the completeness of facilities or general learning outcomes, without specifically examining the influence of the availability of laboratory resources on the quality of science education. This gap in the literature highlights the need for research synthesising various empirical findings to develop a comprehensive conceptual framework. This study aims to analyse the impact of the availability of science laboratory facilities on the quality of science education at secondary school level, based on findings from various published empirical studies in the last five years.

RESEARCH METHODS

Research Design

This research uses a qualitative approach with a literature review method (Systematic Literature Review) that is systematic, explicit, and replicable, with the research aim of identifying, evaluating, and synthesizing studies in articles relevant to the topic being studied, related to facilities and infrastructure in improving learning quality. Systematic Literature Review is a type of literature review that uses a systematic method aimed at collecting secondary data in the form of scientific works, journals, and other relevant sources (Aulia et al., 2023).

According to several researchers who have conducted research with SLR, SLR is defined as follows:

a. SLR is a method to identify, evaluate, and interpret all existing research with specific research questions on an interesting topic or phenomenon.
b. SLR is an evidence-based approach to find studies relevant to several predetermined research questions by selecting, assessing, and synthesizing findings to answer the research questions.
c. SLR is a research technique by analyzing the state-of-the-art in a certain field of knowledge by formally defining the problem questions, information sources, and others.
d. SLR is a research technique used to review or discover issues present in software engineering (Putri et al., 2023)

This approach was chosen because it is able to provide a comprehensive overview of the conditions, trends, and issues related to laboratory facilities and infrastructure over the past five years (2021–2025). This study uses a literature review method with a descriptive qualitative approach that is systematic, explicit, and replicable, with the research aim of identifying, evaluating, and synthesizing studies in articles relevant to the topic being examined, related to facilities and infrastructure in improving the quality of learning.

Data Source

Data was obtained from articles, research journals, expert theories, and books sourced from online journals accessed through websites such as Google Scholar, Google Books, and others. The search keywords used for the data were: "availability of science laboratories," "laboratory facilities and infrastructure," "science learning," and "learning outcomes." The search was limited to articles published between 2021 and 2025 to ensure the relevance and novelty of the research.

Inclusion and Exclusion Criteria

The inclusion criteria in this study include: (1) empirical research articles with quantitative, qualitative, or mixed approaches; (2) discussing the availability of facilities and/or infrastructure of science laboratories; (3) examining its impact on the learning process or learning outcomes of middle school students; (4) published in scientific journals; (5) available in full text; and (6) written in Indonesian or English. Meanwhile, the exclusion criteria of this study include articles in the form of opinions, essays, non-systematic literature reviews, and scientific works that are not published in journals, which are excluded from the analysis process.

Procedure

The research procedure for a systematic literature review with a qualitative approach was carried out by following the steps according to Francis & Baldesari (2006) as described in the table below.

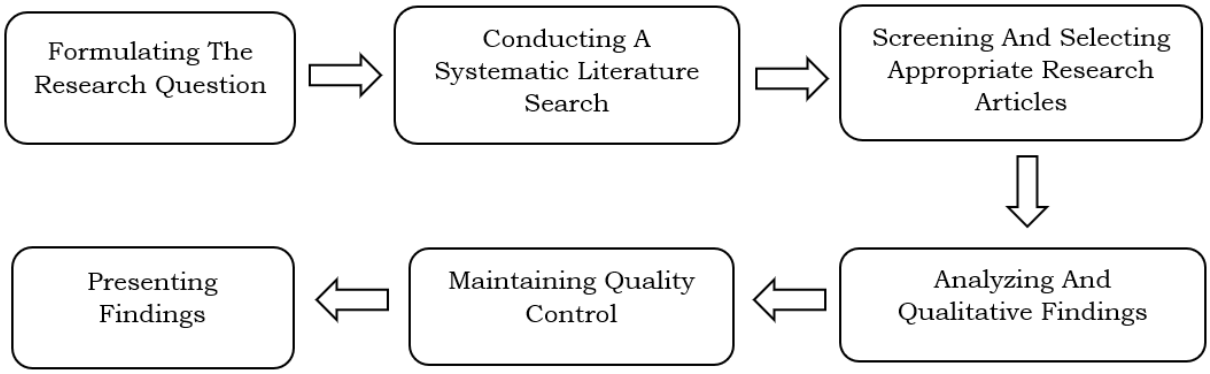


Figure 1. Flowchart of the Systematic Literature Review Process Adapted from Francis and Baldesari (2006)

Data Analysis

The data analysis process in this study uses the meta-synthesis method. Systematic literature review has two types of methods, namely the meta-analysis method and meta-synthesis. In this study, the data analysis technique used is meta-synthesis by integrating data to obtain new theories or concepts or a deeper and more comprehensive level of understanding. Meta synthesis aims to answer research questions by summarizing various research results (Nugroho et al., 2021).

RESULTS AND DISCUSSION

RESULTS

The initial search yielded 50 articles, which were then screened based on inclusion and exclusion criteria, resulting in the selection of 15 relevant articles. Based on the review of the collected articles, an analysis was conducted to describe the impact of the availability of science laboratory facilities and infrastructure on the quality of learning in schools, as shown in the table below.

Table 1. Data Analysis of Research Results on the Influence of the Availability of Science Laboratory Facilities and Infrastructure

No	Author	Publication Year	Article title	Research Result
1.	Rifa Anjiana, Ita Yuliastuti, Alfira Rahayu, Yani Kristiani, Romy Faisal Mustofa	2025	Optimization of Science Laboratory Use in Junior High Schools: Evaluation of Laboratory Facilities Availability and Learning Quality	Research results in the article show that the availability and management of science laboratory facilities directly affect the quality of learning. Limitations in equipment, materials, and maintenance result in suboptimal practical sessions, causing students' understanding of concepts and scientific process skills to be underdeveloped. Conversely, a complete and well-managed laboratory enhances learning effectiveness as well as student learning outcomes.
2.	Wiwit Yuli Lestari,Hertien Koosbandiah Surtikanti, Taufik Rahman, Riandi	2025	Analysis of the Availability and Standardization of Science Laboratory Facilities and Infrastructure to Improve the Science Process Skills of Junior High School Students	The results of research in the Journal of Mathematics and Natural Sciences Education show that the fulfillment of science laboratory facilities and infrastructure in five junior high schools/Islamic junior high schools ranges from 70%–93% and does not fully meet the standards of the Minister of National Education Regulation Number 24 of 2007. Schools with more complete facilities are able to carry out practicums more effectively and support students' science process skills, while limited tools and equipment cause practicums to be less than optimal. This shows that the

No	Author	Publication Year	Article title	Research Result
				availability of science laboratory facilities and infrastructure has a direct impact on the quality of experiment-based science learning.
3.	Nelson Mandela Anane, Vincent Ankamah Lomotey	2023	Perceptions of the Impact Of Availability and Utilization of Laboratory Facilities On Science Teacher-Trainees' Knowledge and Attitudes Toward Improvisation In Science	The research results in the journal indicate that the availability and utilization of science laboratory facilities and infrastructure significantly affect the knowledge and attitudes of prospective science teachers. A well-equipped laboratory allows students to connect theory with practice, thereby enhancing conceptual understanding, while optimal use of the facilities encourages positive attitudes toward improvisation in teaching. Thus, although limitations in resources can be an obstacle, this study affirms that the creative attitudes and improvisation skills of prospective teachers are formed through hands-on laboratory experiences.
4.	Joanna Marie V. Lazaro, Dr. James L. Paglinawan	2025	Laboratory Resource Availability and Students' Engagement in Science	Research results in the journal show that the availability of science laboratory facilities significantly affects student engagement in learning. Adequate laboratory facilities make students more behaviorally active, more able to understand concepts cognitively, and fairly emotionally involved. Correlation analysis shows a moderate positive relationship between the quality of laboratory facilities and the level of student engagement, so it can be concluded that the better the availability of science laboratory facilities, the higher the students' engagement in the science learning process.
5.	Fahmi Muzammal, Muhammad Aamir Hashmi	2025	Analysis Of Available Lab Facilities At Secondary Level	Research in the journal "Analysis of Available Lab Facilities at Secondary Level" shows that the limitations of science laboratory facilities in secondary schools directly affect the quality of science learning, where the lack of facilities makes practical activities less than optimal, causing students to receive more theory than hands-on experience; conversely, schools with complete laboratories are able to enhance student engagement, conceptual understanding, and positive attitudes toward science.
6.	Adedolapo Abdulahi Ahmed, Abdulfatai Muhammed Gazali, Halimat Jummai Kperogi	2025	Availability and utilization of science laboratory apparatus and its impact on the academic performance of senior secondary school students	The research results show that the availability of science laboratory facilities and infrastructure has a positive influence on student learning outcomes. Schools with adequate laboratory facilities enable students to perform practical activities more optimally, thus helping them understand science concepts more concretely and deeply. Furthermore, regular use of laboratories in the learning process also increases student interest, engagement, and motivation to learn. Therefore, the better the availability and utilization of laboratory facilities, the better students' academic achievement in science subjects.

No	Author	Publication Year	Article title	Research Result
7.	Rivo Alfarizi Kurniawan	2021	Analysis of Standardization of Laboratory Facilities, Infrastructure, and Personnel at MTs Negeri 8 Jember	Research results in the journal show that the availability of facilities and infrastructure in science laboratories does not fully meet the standards, in terms of equipment completeness, room conditions, and supporting personnel. This limitation directly affects the effectiveness of science learning because students cannot conduct practical experiments optimally, resulting in underdeveloped science process skills and conceptual understanding. Thus, this research emphasizes that the more complete and standards-compliant the laboratory facilities and infrastructure are, the greater their positive impact on the quality of science learning.
8.	Anisa Haffifa, Abdul Kosim	2023	Management of Science Laboratory Facilities and Infrastructure at State Islamic Senior High School 2 Karawang	Research findings in the journal show that the availability and management of good science laboratory facilities positively affect the effectiveness of science learning. A complete and well-managed laboratory allows students to conduct practical work optimally, thereby enhancing their understanding of concepts, skills, and interest in learning. Conversely, limited facilities make learning more theoretical and less engaging.
9.	Salza Ace Lianda, Emayulia Sastria, Nosi Qadariah	2025	Analysis of Science Laboratory Standardization at SMPN 5 Kerinci with National Laboratory Standards	The results of the study indicate that the availability and utilization of science laboratory facilities and infrastructure have a significant influence on student learning outcomes. Schools with more complete and well-functioning laboratory facilities tend to show higher student academic achievement than schools with limited facilities. Furthermore, the intensity of laboratory use in practical activities also contributes to increased conceptual understanding, science process skills, and student learning motivation. These findings confirm that the quality of science learning is strongly influenced by the support of adequate laboratory facilities and their optimal use in the learning process.
10.	Purwati, Rahmiati Darwis, Nur Alim Natsir	2025	The Effectiveness of Virtual Science Laboratories in Improving Science Process Skills of Seventh Grade Students on the Material of Temperature and Heat	Research results in journals show that the use of virtual laboratories can be a solution when the facilities and infrastructure of real science laboratories are limited. Virtual laboratories have been proven effective in improving students' science process skills, particularly in understanding the concepts of temperature and heat, as well as providing practical experience despite inadequate physical facilities.
11.	Deva Kurniawati, Wahono Widodo	2023	Analysis of Laboratory Utilization in IPA Learning at SMP/MTs	The research results in the journal indicate that the availability of science laboratory facilities and infrastructure has a significant effect on the effectiveness of learning, where schools with complete laboratory facilities can improve science process skills, conceptual understanding, and student learning

No	Author	Publication Year	Article title	Research Result
				motivation, while limitations in facilities become the main obstacle that reduces the optimization of practical activities.
12.	Bela Mustika, Afreni Hamidah	2025	Facilities and Infrastructure in Improving Learning Quality Based on Recent Literature Review 2020-2025: A Systematic Literature Review (SLR)	Based on research results, the availability of science laboratory facilities and infrastructure has been proven to positively influence the quality of learning. Laboratories that are fully equipped and meet standards can improve learning effectiveness, practical skills, conceptual understanding, and student motivation. Conversely, limited tools and materials for practical work can hinder learning and reduce learning interest. In addition to complete facilities, good laboratory management and the use of technology are also important factors in supporting optimal learning. Therefore, the more adequate and well-managed laboratory facilities and infrastructure are, the more the quality of science learning in schools will improve.
13.	Alufatuz Zakiyah, Indah Kurniawati, Annisa Nurul Firdaus, I. Ketut Makardika	2022	The Influence of Science Laboratory Facilities on the Learning Motivation of 7th Grade Students at SMP Negeri 10 Jember	Research results show that the availability of science laboratory facilities and infrastructure at SMP Negeri 10 Jember is still inadequate, which affects students' low learning motivation. Many laboratory facilities are damaged, and the practical materials are unusable, causing practical activities to run only about 50% of the plan. In addition, laboratory management is not yet optimal because science teachers also serve as lab assistants, limiting the time available to prepare equipment and materials. This condition prevents laboratory activities from running according to standards, resulting in students being less actively involved and their learning motivation decreasing.
14.	Miftahul Hasanatun Alfiah, Bramastia	2023	Challenges and Opportunities in Science Laboratory Management in Secondary Schools: A Recent Literature Analysis	Researchers found that the availability of science laboratory facilities and infrastructure significantly influences the quality of science learning in secondary schools. Laboratories that meet the standards stipulated in the Indonesian Minister of Education, Culture, Research, and Technology Regulation Number 22 of 2023 enable effective practicum implementation, increase learning motivation, and optimally develop students' science process skills. Conversely, limited space, equipment, and laboratory management lead to learning that tends to be theoretical, less interactive, and less supportive of in-depth conceptual understanding. Therefore, the more adequate the laboratory facilities and infrastructure, the higher the quality of science learning.
15.	Nadya Rahmatika Ulya, Agusti Rona Ayu Widari, Azka Amilatul Fadila	2025	The Role of Facilities and Infrastructure in Creating an Effective Learning Environment	Research results in the journal show that the availability of facilities such as a complete and active science laboratory greatly influences the effectiveness of learning. A representative laboratory can increase student engagement, create an enjoyable learning atmosphere, and

No	Author	Publication Year	Article title	Research Result
				encourage students' abilities to solve problems and complete experiments. This research emphasizes that the management and optimal use of facilities, including science laboratories, significantly contribute to the quality of education and student learning outcomes.

Based on the results of a systematic review of 15 identified journals, the following presents a thorough analysis discussion covering four main aspects, namely the identification of research problems and objectives, research design and data collection techniques, data analysis techniques along with the degree of confidence in the findings, as well as results, discussion, and novelty of the research. These four aspects are discussed in sequence to provide a comprehensive overview of the conditions, patterns, and trends found in the literature review on science laboratory facilities and infrastructure in schools.

Analysis of Problem Identification and Research Objectives

A review of 15 articles revealed a consistent focus on the gap between the actual conditions of science laboratories in the field and the standards that should be met. (Anjiana et al., 2025; Lestari et al., 2025; Lianda et al., 2025; Sari et al., 2023) consistently found that many school laboratories do not yet meet the provisions of Ministry of Education Regulation No. 24 of 2007. The problems that arise vary, ranging from inadequate equipment, limited consumables, insufficient safety facilities, rooms that do not meet size standards, to furniture that is far from ideal.

In addition to physical issues, the governance dimension has also been highlighted in several studies. (Alfiah, 2023; Kurniawati & Widodo, 2023) indicate that laboratory management in many schools is not functioning effectively. The absence of professional laboratory staff, weak administrative systems, and insufficient evaluation of laboratory work programs exacerbate these conditions. The impact of these limitations on the learning process has also drawn attention: (Ahmed et al., 2025; Anane & Lomotey, 2023; Lazaro & Paglinawan, 2025; Zakiyah et al., 2022) found that inadequate laboratory facilities directly result in reduced learning motivation, decreased active participation, weakened academic performance, and hindered development of scientific process skills.

In terms of research objectives, the four most common focuses were: evaluating the availability of laboratory facilities, assessing their compliance with national standards, analyzing patterns of laboratory use, and examining their impact on student learning outcomes. A synthesis of the articles revealed that most studies remain concentrated on the mapping and evaluation stages, while research focused on developing models or concrete solutions remains very limited.

Research Design Analysis and Data Collection

From a methodological perspective, the two most commonly used approaches are quantitative descriptive and qualitative descriptive. (Anjiana et al., 2025; Lestari et al., 2025; Lianda et al., 2025; Muzammal Fahmi, 2025; Sari et al., 2023) applied a quantitative descriptive approach relying on percentage calculations and checklist instruments based on national standards. This approach effectively produces a measurable and objective quantitative picture of the level of fulfillment of laboratory infrastructure. On the other hand, (Hafifa & Kosim, 2023; Kurniawati & Widodo, 2023; Siregar, 2025) chose a qualitative descriptive approach to explore deeper insights into laboratory management practices and teachers' perspectives.

Data collection techniques almost exclusively combine multiple instruments simultaneously. Direct observation is used to verify the actual conditions of the laboratory, checklists serve as standardized evaluation tools, interviews are utilized to explore the perspectives of teachers and laboratory staff, and questionnaires are used to measure student motivation and perceptions (Zakiyah et al., 2022). Overall, the dominance of the descriptive approach indicates that studies on science laboratories remain centered on the diagnostic stage and have not yet moved significantly toward experimental research or model development.

Analysis of Data Analysis Techniques and Degree of Confidence in Findings

The most commonly used data analysis techniques are descriptive statistics, including percentage calculations, categorization of completeness levels, and frequency tabulation. (Anjiana et al., 2025; Lestari et al., 2025; Saputri et al., 2025) applied this technique to classify laboratory

conditions into several categories, ranging from very complete to incomplete. Some further studies used inferential analysis in the form of correlation tests to uncover the relationship between laboratory conditions and student learning achievement. (Ahmed et al., 2025; Lazaro & Paglinawan, 2025; Zakiyah et al., 2022) consistently found a positive relationship between the completeness of laboratory facilities and learning motivation, student engagement, and academic achievement.

In research using a qualitative approach, analysis was conducted through three stages: data reduction, data presentation, and thematic conclusion drawing. Regarding the reliability of the findings, several studies demonstrate sound methodological quality; however, certain limitations remain, including small sample sizes, limited geographical scope, and a tendency for studies to focus on a single educational institution. Therefore, while the findings are reasonably credible within their respective local contexts, generalizing the results to a broader scale should be done with caution.

Analysis of Results, Discussion, and Novelty of the Research

A synthesis of all the articles leads to the general conclusion that science laboratories in the schools studied do not yet fully meet the required standards, whether in terms of physical facilities, utilization in teaching, or institutional management. (Anjiana et al., 2025; Lianda et al., 2025; Sari et al., 2023) found that although some schools have laboratories in relatively adequate condition, certain aspects such as the availability of proportionate space, the completeness of furniture, workplace safety facilities, and the supply of consumables still require serious attention.

In terms of utilization, (Hafifa & Kosim, 2023; Kurniawati & Widodo, 2023) found that, in practice, laboratories are not yet being used optimally. Limited time allocation, a lack of teacher readiness and competence in managing practical activities, and a weak laboratory administration system are the most frequently identified barriers. Meanwhile, (Ahmed et al., 2025; Anane & Lomotey, 2023; Lazaro & Paglinawan, 2025; Zakiyah et al., 2022) highlight another perspective: that well-functioning laboratories can significantly enhance student motivation, learning outcomes, engagement, and scientific attitudes.

In terms of innovation, (Purwati & Nur, 2025) offer a breakthrough by developing virtual laboratories as an alternative solution to address the limitations of physical facilities while also promoting the development of scientific process skills. Meanwhile, (Alfiah, 2023; Mustika & Hamidah, 2025) highlight the significant potential of digitizing laboratory administration through the use of specialized management software as a strategic step to improve management efficiency.

Discussion

A synthesis of 15 research articles indicates that the quality of science education is significantly influenced by the integration of the availability, standardization, management, and safety aspects of laboratory facilities and equipment. When various research findings are compared, it becomes evident that the quality of science education is largely determined by the interaction among these four factors.

First, from the perspective of availability and standardization, various studies show a consistent pattern: the mere availability of facilities is not sufficient; they must also meet standards and be relevant to the curriculum (Kurniawan, 2021). Findings by (Anjiana et al., 2025; Muzammal Fahmi, 2025) indicate that limitations or mismatches between equipment and learning needs result in suboptimal laboratory sessions. This is reinforced by (Lestari et al., 2025; Lianda et al., 2025), who demonstrate that disparities in standardization across schools result in variations in learning quality. Thus, it can be synthesized that standardization serves as a bridge between facility availability and learning effectiveness. Student engagement and motivation emerge as indirect yet significant effects of laboratory facility quality. (Lazaro & Paglinawan, 2025; Zakiyah et al., 2022) demonstrate that adequate facilities enhance active participation and student motivation, affirming that laboratories impact not only cognitive aspects but also affective and psychomotor aspects.

Second, regarding the implementation of standards, research reveals a gap between policy and practice. Although national standards have been established, (Lestari et al., 2025; Lianda et al., 2025) found that many schools have not yet been able to fully meet these standards. (Hafifa & Kosim, 2023) highlight budget constraints as the primary barrier. From this, it can be concluded that the main issue is not the absence of standards, but rather the capacity for implementation and the sustainability of their management. Teachers' competence in managing laboratories is also a determining factor; (Anane & Lomotey, 2023) demonstrate that understanding of standards and laboratory management directly influences the effectiveness of their use, so improving the quality of learning requires a systemic approach that does not focus solely on physical facilities.

Third, the safety aspect highlights another dimension that is often overlooked but crucial. Findings by (Ahmed et al., 2025; Anane & Lomotey, 2023) indicate that low understanding of and compliance with safety procedures can hinder learning and even have psychological effects on students. (Lazaro & Paglinawan, 2025) show that limited facilities also increase the risk of accidents. Thus, it can be concluded that safety is not merely a technical aspect but a primary prerequisite for creating an effective learning environment. (Purwati & Nur, 2025) propose an alternative through safer virtual laboratories, indicating a paradigm shift where technology can serve as a solution to the limitations of physical facilities and safety risks.

Fourth, disparities in school facilities have become a structural issue that exacerbates inequalities in educational quality. (Lazaro & Paglinawan, 2025; Muzammal Fahmi, 2025; Ulya et al., 2025) indicate that urban schools have superior facilities compared to rural schools. Linked to the findings of (Zakiyah et al., 2022), this disparity not only affects the learning experience but also student motivation and achievement, thereby potentially widening the national education gap.

Overall, it is clear that the quality of science education is influenced by various interrelated factors: availability of facilities, compliance with standards, effective management, safety aspects, and equitable access. If any of these factors is lacking, learning will not proceed optimally. Therefore, improving the quality of science education cannot be done in isolation but must be implemented comprehensively and sustainably.

CONCLUSIONS

Based on the results and discussion of the Systematic Literature Review (SLR) of 15 research articles, it can be concluded that the availability of science laboratory facilities and equipment has a significant and positive impact on the quality of science education in secondary schools. Well-equipped, standardized, and well-managed laboratories have been shown to enhance learning effectiveness, scientific process skills, conceptual understanding, learning motivation, student engagement, and overall learning outcomes. Conversely, limited facilities, non-compliance with national standards, inadequate maintenance, and poor laboratory management result in learning that tends to be theoretical, less interactive, and less effective in developing students' scientific abilities. Facility disparities among schools also affect the quality of students' learning experiences and academic abilities, which has the potential to create inequalities in the quality of science education. Therefore, the systematic provision, standardization, and management of laboratory infrastructure supported by attention to safety and equitable access are key factors in sustainably improving the quality of science learning in schools.

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