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The effect of physics laboratory standardization on students' interest in learning physics in grades X and XI senior high school

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Abstract

The physics laboratory plays an important role in science learning by supporting experiments that enhance students' conceptual understanding and interest in learning. This study aims to analyze the level of physics laboratory standardization at SMA Negeri 1 Turi and its relationship with the learning interest of grade X and XI students. The method used is descriptive, with a mixed-methods approach, using an Explanatory Sequential design through observation, questionnaires, interviews, and documentation. The results showed that the laboratory's infrastructure (90%) and facilities (87%) were very good, while staff (33%) were still lacking, and management (62.7%) was only adequate. The implementation of the laboratory in learning obtained a score (67.5%) in the good category, but its use as an assessment was not optimal. The questionnaire and interviews confirmed that practicums increased students' enthusiasm for learning, although limited staff and management made the activities less routine. Thus, the physics laboratory at SMA Negeri 1 Turi has strong infrastructure and facilities but needs improvement in staffing and management to support students' learning interests better.

INTRODUCTION

Physics is a branch of natural science acquired through systematic observation and experimentation. Learning physics requires observation and experimentation to support students' understanding of the concepts being studied. (Qomariyah and Wirawan, 2018)Through experiments or trials, students can directly demonstrate concepts, making them easier to understand. Therefore, the physics laboratory plays a crucial role as a learning tool that supports conceptual understanding through practical activities. Experiments allow students to test theories and connect physics concepts to real-world phenomena. (Ekawati, Sunarno, and Cari, 2018). Adequate laboratory facilities are the main prerequisite for the success of practical-based learning (S. Laili et al., 2025). Comprehensive equipment and materials help students understand abstract concepts through hands-on experience. Practical-based physics learning effectively improves students' understanding of physics concepts and scientific thinking skills.

Laboratories are facilities for conducting scientific research, measurements, experiments, and scientific training. The existence of physics laboratories is a crucial requirement in modern science education because they support the cognitive domain while

developing students' affective and psychomotor domains.(Juliandari, Dewi and Angreani, 2025)Through direct involvement in experimental and observational activities, students not only gain a theoretical understanding of physics concepts but also experience how these concepts operate in real life.(Noble and Pure, 2022)Experiments foster affective skills, such as honesty, curiosity, and responsibility. Practical activities also develop psychomotor skills, such as using tools, analyzing data, and communicating experimental results accurately. Therefore, a well-managed laboratory is key to successful learning and student competency achievement.

A good laboratory meets established standards. Articles 42 and 43 of Government Regulation No. 19 of 2005 stipulate that every school must have infrastructure comprising laboratory space, scientific equipment that meets the required standards, and a minimum list of learning equipment. Furthermore, the Minister of National Education Regulation No. 24 of 2007 establishes minimum standards for educational facilities and infrastructure from the elementary to the high school levels, including standards for physics laboratories. This standardization covers buildings, furniture, educational equipment, educational media, and other supporting facilities, enabling the laboratory to function optimally in supporting science learning. Furthermore, laboratory management requires specialized personnel, including a laboratory head, laboratory assistants, technicians, and physics teachers, each with distinct responsibilities to ensure the laboratory operates in accordance with standards.(Akma, 2023)Thus, a laboratory that meets standards will directly improve the quality of physics learning in schools.

A laboratory that meets standards can provide authentic scientific experiences for students, enabling them to understand physics concepts not only in theory but also through real-world applications. Complete facilities support the development of science process skills and scientific attitudes, such as observation, data analysis, and scientific communication. Therefore, laboratory standardization plays a crucial role in improving the quality of learning. This aligns with Kusyanti's (2022) findings, which state that a physics laboratory that meets standards is ready to support the implementation of the Independent Curriculum. A similar view was expressed by Fari, Subagiyo, and Zulkarnaen (2024), who emphasized that improving the quality of physics learning is difficult to achieve without effective laboratory management. Therefore, laboratory management is an inseparable part of all laboratory activities.

In reality, the number, shape, size, quality, and location of physics laboratories in secondary schools can vary depending on each school's conditions and needs. Previous research conducted byAnggereni, Suhardiman and Amaliah (2021)The results showed that the availability of equipment, teaching materials, administrative support, and the implementation of practical activities in the physics laboratories of State Senior High Schools in Pangkajene District, Pangkajene Regency, and the Islands were in the insufficient category. These findings indicate that many schools still face obstacles in meeting physics laboratory standards. However, according toSiregar (2020)The laboratory should include a main room for practical activities and additional rooms, such as storage and preparation areas, with facilities and equipment that meet standards, ensuring that practical activities run smoothly.

SMA Negeri 1 Turi is one of the senior high schools in Sleman Regency. This school was chosen because it is where the researcher conducted the teaching practice. This school has several laboratory rooms used for practical activities, including a physics laboratory. Based on this background, the researcher is interested in identifying the level of standardization of the physics laboratory at SMA Negeri 1 Turi and whether the laboratory is adequate and functioning optimally. In addition, this study aims to gather information on the extent to which laboratory standardization influences the quality of physics learning and student interest in learning. Thus, the purpose of this study is to analyze the level of standardization

of the physics laboratory at SMA Negeri 1 Turi and its relationship to the learning interests of grades 10 and 11.

METHOD

This research uses a descriptive method with a quantitative and qualitative approach (mixed methods). This study employed an explanatory sequential design, which begins with the collection and analysis of quantitative data with a dominant weight, followed by the collection and analysis of qualitative data at a lower weight (to deepen the results). (Khabibullah, Alimin, and Sholahuddin, 2024)This research was conducted at SMA Negeri 1 Turi. The research period was from July 22 to September 26, 2025. The research subjects included the laboratory head, physics teachers, and students in grades X and XI. Research data were also obtained through observations of laboratory facilities and infrastructure. Questionnaires were given to teachers and students to measure their perceptions. Researchers also conducted interviews with teachers and students to strengthen the research findings, focusing on their views on physics learning in the laboratory.

This study used a purposive sampling technique, selecting the population and informants based on the research objectives. Data collection techniques included observation, interviews, questionnaires, and documentation. Data analysis was carried out in several stages. The first stage was data collection from observations, interviews, questionnaires, and documentation. The second stage involved data reduction by summarizing and selecting key points, resulting in clear, concise information. The third stage involved data analysis and tabular presentation. Observation data were adjusted in accordance with the Minister of National Education Regulation Number 24 of 2007. The observation scores were summarized, calculated as percentages, and then classified according to Table 1.

Table 1. Classification of Laboratory Facilities and Infrastructure Standardization

Percentage (%)	**Classification**
85% < x ≤ 100%	Very good
65% < x ≤ 85%	Good
45% < x ≤ 65%	Enough
25% < x ≤ 45%	Not enough
0% < x ≤ 25%	Very less

(Mastika, Adnyana and Setiawan, 2014)

Analysis of teacher and student questionnaires using a Likert scale, with scale guidelines presented in Table 2.

Table 2. Likert Scale Scoring Guidelines

Score	**Information**
5	Strongly agree
4	Agree
3	Disagree Less
2	Don't agree
1	Strongly Disagree

(Sugiyono, 2013)

The percentage of student and teacher responses can be calculated using the formula:

$$P = \frac{\sum x_i}{x} \times 100\%$$

(Agustina, 2015)

Information:

P: Assessment presentation

∑xi: Total number of respondents' answers in all items

∑x: Total ideal score

To find out the results of the analysis of student and teacher responses using the criteria in Table 3.

Table 3. Student and Teacher Response Criteria

Percentage (%)	Classification
80% ≤ P < 100%	Very Good
60% ≤ P < 80%	Good
40% ≤ P < 60%	Pretty good
20% ≤ P < 40%	Not good
P < 20%	Very Poor

(Arikunto, 2010)

Meanwhile, qualitative data analysis from teacher and student interviews includes data reduction, data presentation, and conclusion.

FINDINGS AND DISCUSSION

The references used in this study are the Minister of National Education Regulation Number 24 of 2007 concerning Standards for Facilities and Infrastructure and the Guidelines for Standardization of Buildings and Furniture for Senior High Schools (Ministry of Education and Culture, 2011). Both documents set minimum standards that schools must meet, including requirements for laboratory space, room width, and storage. The comparison of actual conditions with these minimum standards is shown in Table 4.

Table 4. Physics Laboratory Room

Name of goods	Minimum Physics Lab Standards	Physics Lab at SMAN 1 Turi	Percentage (%)
Lab room 36 students	86.4m^2	126m^2	100
Lab width	5 m	8 m	100
Storage Space	18m^2	12, 6m^2	70
Average			90

Based on the observation results in Table 4, the condition of the physics laboratory infrastructure at SMA Negeri 1 Turi has largely exceeded the established minimum standards. The laboratory space has an area of 126 m², exceeding the minimum standard of 86.4 m², and is therefore categorized as very good (100%). The room width also reaches 8 m, exceeding the minimum standard of 5 m, and is classified as very good (100%). However, in terms of storage space, the available area is only 12.6 m², which falls short of the minimum standard of 18 m², so it is only 70% and is categorized as good. On average, the condition of the physics laboratory infrastructure received a 90% score and is classified as very good.

The observation results were reinforced by quantitative analysis of teacher and student questionnaires using a Likert scale. Most teachers agreed that the laboratory conditions met the standards for facilities and infrastructure, while students also assessed the laboratory as being in good condition to support learning. The average score percentage of respondents was in the good-to-very good range (≥ 80%), in line with observations that classified the

infrastructure as very good. However, interviews with teachers and students confirmed that limited storage space still hampers equipment arrangement, requiring some equipment to be placed in other rooms. This condition sometimes makes it difficult for students to find equipment during practicums. Thus, although the overall infrastructure of the physics laboratory is very good, storage space needs improvement to enable more effective equipment management and optimal practicum activities.

Physics laboratory facilities include furniture, experimental equipment, media, and other equipment to support practical activities. The results of observations of the condition of facilities at SMA Negeri 1 Turi are presented in Table 5.

Table 5. Physics Laboratory Facilities

Type	Percentage (%)	Category
Educational Equipment Furniture	86	Very good
Experimental tools	91.67	Very good
Educational Media	100	Very good
Other equipment	70	Good
Average	87	Very good

Based on Table 5, the physics laboratory facilities at Turi State Senior High School 1 generally meet the standards and are categorized as very good. Educational furniture and equipment achieved a score of 86%, experimental equipment 91.67%, and educational media 100%, all of which fall into the very good category. However, other equipment only achieved a score of 70%, or good, particularly for work safety support facilities and incomplete cleaning equipment. Overall, the laboratory facilities achieved an average score of 87%, categorized as very good.

Analysis of teacher and student questionnaires supported these findings. Most teachers agreed that laboratory facilities facilitated understanding of physics concepts, despite the limited number of tools. Students assessed the facilities as good, but said that practical work was not always carried out routinely. The percentage of teacher and student responses ranged from good to very good (65%–85%), in line with observation results. Interviews confirmed that limited tools meant students had to take turns during practical work. Therefore, it can be concluded that the physics laboratory facilities at SMA Negeri 1 Turi are in the very good category, although their utilization still needs improvement.

Laboratory personnel were analyzed in accordance with the minimum qualification standards stipulated in Minister of National Education Regulation No. 26 of 2008, which require a laboratory head, technicians, and laboratory assistants. The actual condition of laboratory personnel at SMA Negeri 1 Turi is shown in Table 6.

Table 6. Laboratory Personnel Qualifications

Type	Minimum Physics Lab Energy Standards	Conditions at SMAN 1 Turi	Percentage (%)
Head of Lab	Bachelor's, certified, Minimum 3 years managing a lab	Bachelor's, Certified, managing for more than 3 years	100
Technician	D2, certificate	There isn't any	0
Laboratory assistant	D1, certificate	There isn't any	0
Average			33.3

Based on Table 6, only the laboratory head met the qualification standards, namely a bachelor's degree in physics with more than three years of experience, thus achieving a score of 100% and the excellent category. However, neither technicians nor laboratory assistants were available at all, even though they should have been provided in accordance with the minimum standard. This situation resulted in the overall average laboratory workforce of only 33%, which is considered inadequate.

Teacher interviews corroborated these findings. Teachers stated that the absence of technicians and laboratory assistants meant that all laboratory management tasks, from equipment inventory to laboratory preparation, had to be handled solely by the physics teacher. As a result, laboratory preparation was often hampered, resulting in delays in implementation. Students also reported that when the laboratory began, the equipment was sometimes not fully ready. Questionnaire analysis showed that the majority of teacher and student respondents agreed that additional laboratory personnel were needed. Therefore, although the laboratory head met the required qualifications, the physics laboratory staff at SMA Negeri 1 Turi remained inadequate due to the shortage of technicians and laboratory assistants.

Laboratory management is analyzed based on the laboratory head's competencies as stipulated in the Minister of National Education Regulation Number 26 of 2008, including planning, activity management, task allocation, monitoring, and performance evaluation. The condition of the physics laboratory management at SMA Negeri 1 Turi is shown in Table 7.

Table 7. Physics Laboratory Management

Competence	**Percentage (%)**	**Category**
Develop a development plan	100	Very good
Managing activities	100	Very good
Division of tasks between laboratory technicians and technicians	0	Very less
Monitoring facilities and infrastructure	80	Good
Evaluate the performance of laboratory assistants, technicians, and laboratory activities	33.3	Not enough
Average	62.7	Enough

Based on Table 7, physics laboratory management at SMA Negeri 1 Turi achieved an average score of 62.7%, which is considered adequate. The planning (100%) and activity management (100%) aspects are excellent, as evidenced by the availability of work program planning documents and the implementation of scheduled practical activities. However, the division of tasks between laboratory assistants and technicians received a 0% score due to a lack of laboratory personnel at the school. Furthermore, monitoring of facilities and infrastructure (80%) is only in the good category, and laboratory performance evaluation (33.3%) is considered inadequate. These conditions indicate that although management is strong in planning and management, the evaluation and division of tasks have not been optimally implemented.

Teacher interviews supported these findings. Teachers reported that, due to a lack of laboratory assistants or technicians, the physics teacher was responsible for all tasks, leading to poorly managed laboratory activities. Evaluations were also limited to recording equipment usage without a comprehensive follow-up. Students reported that during lab work, there was rarely direct supervision regarding equipment usage procedures, so evaluations focused more on experimental results. Questionnaire analysis showed that teachers and students, on average, rated management as fair to good (45%–75%), consistent with observations. Therefore, although planning and implementation aspects were excellent, overall laboratory

management was still considered adequate and needed improvement, particularly in the evaluation and division of laboratory staff tasks.

The implementation of laboratories in physics learning was analyzed in light of the learning and assessment principles in the Independent Curriculum. The results of the physics laboratory observations at SMA Negeri 1 Turi are shown in Table 8.

Table 8. Classification of curriculum implementation

Aspect	Percentage (%)	Category
Learning principles	75	Good
Assessment principles	60	Good
Average	67.5	Good

Based on Table 8, the implementation of laboratories in physics learning achieved an average score of 67.5%, which is considered good. The learning principles aspect received a score of 75%, which is regarded as good, indicating that the laboratories have been used to support the learning process, although not optimally. The assessment principles aspect achieved only 60%, which is still considered adequate but indicates that laboratories as an assessment tool have not been used consistently, as required by the Independent Curriculum.

The results of teacher and student questionnaires supported these findings. Teachers stated that laboratory utilization was indeed helpful in learning, but it had not been fully integrated into formative or summative assessments. Students also noted that lab work made it easier for them to understand concepts, but these activities were not always used as the basis for evaluations. Interviews further stated that limited time and equipment were factors preventing lab work from being routinely used in assessments. Therefore, the implementation of the physics laboratory at SMA Negeri 1 Turi is considered good. Still, improvements in assessment are needed to optimize the laboratory's role in supporting the Independent Curriculum.

Theoretically, laboratories that meet standard facilities and infrastructure play a crucial role in creating a conducive learning environment. The availability of adequate infrastructure and facilities provides students with opportunities to learn through hands-on experience, thereby increasing motivation and interest in learning. Physics practicums conducted with the support of standard laboratory facilities enable students to understand abstract concepts and make them concrete more easily, fostering their curiosity and interest in physics.

The results of this study strengthen this relationship. Observational data indicate that the infrastructure (90%) and facilities (87%) of the physics laboratory at SMA Negeri 1 Turi meet the standards in the very good category, as reflected in student interviews, which stated that they were more enthusiastic when learning was carried out through practicums. However, limited laboratory personnel (33% – in the poor category) and laboratory management (62.7% – in the adequate category) resulted in practicum activities not always being carried out optimally. Students stated that their learning interest increased when practicums were conducted, but decreased when these activities were conducted infrequently or at a late stage. Teacher and student questionnaires supported this finding, with the majority of respondents reporting that the laboratory supported learning, although its use was inconsistent.

Thus, the relationship between laboratory standardization and student learning interest is evident: standardized infrastructure and facilities offer significant potential to increase learning interest, but this influence can be fully realized only if the laboratory's staffing and management are improved. Optimizing laboratory utilization routinely and integrating it into learning will be key to ensuring that physics laboratories not only meet standards but are truly effective in encouraging learning interest in grades 10 and 11.

CONCLUSION

This study shows that the standardization level of physics laboratory in SMA Negeri 1 Turi generally meets the criteria with infrastructure (90%) and facilities (87%) in the very good category, but the aspect of laboratory personnel (33%) is still lacking due to the absence of technicians and laboratory assistants, and management (62.7%) is only adequate, especially in the division of tasks and evaluation. The implementation of the laboratory in physics learning obtained a score of 67.5% in the good category, although its use as an assessment tool has not been maximized. The relationship between students' learning interests and the results of questionnaires and interviews is evident: students are more enthusiastic when practicums are conducted. Still, limited personnel and weak management make practicum activities non-routine, so the potential for increasing learning interest has not been fully realized. Thus, the physics laboratory at SMA Negeri 1 Turi is classified as very good in terms of infrastructure and facilities but needs improvement in personnel and management to be more optimal in supporting the learning interests of grade X and XI students.

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