Berkala Ilmiah Pendidikan Fisika
https://ppjp.ulm.ac.id/journal/index.php/bipf
e-ISSN: 2549-2764 p-ISSN: 2337-604X
Vol 13 No 3 2025
DOI: 10.20527/bipf.v13i3.22960

Qualitative Analysis of MA Students' Perceptions of Measurement Practices in Physics Learning

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Article Info

Article history:
Received: June 20, 2025
Accepted: July 18, 2025
Published: October 29, 2025

Keywords:
Measurement
Qualitative approach
Physics practicum
Student perception

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Abstract

Physics learning as part of science emphasizes a balance between theoretical understanding and practical skills. Practicums are an important means of developing these skills through direct observation, measurement, and data analysis grounded in physics concepts. This study aims to analyze the perceptions of Madrasah Aliyah (MA) students towards the implementation of measurement practicums in physics learning. Measurement practicums are a basic part of physics experiments that aim to develop science process skills and strengthen conceptual understanding. This study uses a descriptive qualitative approach, with data collected through semi-structured interviews, observation, and documentation. The study's subjects were grade X MA students who had participated in the measurement practicum. The results showed that most students had a positive perception of the practicum, especially regarding improvements in conceptual understanding, skills in using measuring instruments, and learning motivation. However, several obstacles were also identified, including limited tools, limited practicum time, and a lack of teacher guidance during the activity. These findings indicate the importance of improving the quality of practicum implementation by providing adequate facilities and strengthening the role of teachers as facilitators. This study contributes as a basis for developing a more effective and meaningful laboratory-based physics learning strategy for MA students.

To cite this article: Nurhidayah, N., Djumaria, D., & Yayuk, E (2025). Qualitative analysis of ma students' perceptions of measurement practices in physics learning, *Berkala Ilmiah Pendidikan Fisika*, *13*(3), 335-352.

INTRODUCTION

Physics, as a branch of science, has abstract and conceptual characteristics. Therefore, physics learning does not only emphasize mastery of theory but also practical skills through laboratory activities. One form of such activity is practicum, which plays an important role in strengthening students' conceptual understanding and scientific skills (Geschwind et al., 2024; Syahwin et al., 2022; Yusuf, 2019). Basic materials, such as measurement, are the foundation of every physics experiment because almost all practical activities depend on the ability to measure and read measuring instruments accurately. Measurement practicums also help students develop empirical understanding, increase learning motivation, and bridge theory and practice (Masyitha et al., 2023; Septaria et al., 2025)).

In measurement material, students learn to recognize basic and derived quantities, international units (SI), the level of accuracy of measuring instruments, and the concept of uncertainty. Measuring instruments such as rulers, calipers, micrometer screws, and scales provide students with concrete experiences in making accurate measurements. Without direct practice, these concepts are often difficult to understand abstractly (Adiyasa et al.,

2022; Sedaghatjou, 2019). Therefore, the implementation of effective measurement practicums is essential to form a deep scientific understanding.

In the context of Madrasah Aliyah (MA), the implementation of measurement practicums plays an important role in improving students' cognitive and psychomotor skills and strengthening their conceptual understanding of science. Studies show that practicum-based learning can increase learning motivation due to students' active involvement in the scientific process (Supriadi, 2020). Students who participate in practicum activities tend to show greater enthusiasm than those using theoretical learning methods because they can connect physics concepts to real-world applications (Saputra, 2019; Supriadi, 2020). This is consistent with Supriadi's (2020) view that practicum-based learning can improve students' conceptual understanding by engaging them actively in the learning process. Measurement is not just about numbers and tools, but part of the scientific thinking process that hones students' accuracy and insight in observing physics phenomena.

In addition, students' perceptions of practicums are greatly influenced by the availability of laboratory facilities and active involvement in experiments, which contribute to an in-depth understanding. Physics is a discipline that has an important role in education, especially in developing scientific thinking and psychomotor skills. Scientific processes in physics, such as observation, measurement, experimentation, and data analysis, enable students to understand natural phenomena systematically and based on evidence (Deva & Wahono, 2023; Ramadani et al., 2024; Yuliana et al., 2017). Practical-based learning has been shown to be effective in improving students' psychomotor skills, especially in the use of measuring instruments such as micrometer screws and vernier calipers. With an experimental-based approach, students not only learn theory but also develop critical thinking and problem-solving skills, which are essential in facing the challenges of the 21st century (Zalukhu et al., 2025; Haspen & Syafriani, 2022).

Physics learning at the MA level has a strategic role in shaping students' scientific thinking skills, problem-solving, and scientific literacy. Therefore, physics learning is not only oriented towards mastering theory but also emphasizes science process skills such as observing, classifying, measuring, interpreting data, and formulating conclusions (Hasanah et al., 2025; Hu et al., 2017)

However, in various educational units, the implementation of physics practicums is often not optimal. Problems that often arise include limited laboratory facilities, lack of practice time, and low active student involvement during practicums. These limitations affect the quality of students' understanding of basic measurement concepts, which can reduce student participation and interest in learning. Studies show that the main obstacles in implementing practicums are the minimal budget for practicum equipment, lack of teacher training in the use of laboratories, and low school policy support for practicum-based learning (Jannah, 2020; Riyanto & Susanti, 2023). In addition, the lack of laboratory staff and teachers' high workloads are factors that hinder the effectiveness of practicums. The concrete implications of this problem include students' low analytical and problem-solving skills, which lead to difficulties in understanding abstract physics concepts and to a lack of readiness to face academic and professional challenges (Pratiwi et al., 2025; Tindan & Arthur, 2024; Fidiana et al., 2012). This has the potential to undermine students' understanding of basic measurement concepts and to reduce interest in physics learning as a whole.

Students' perceptions of practical activities are an important indicator for evaluating the effectiveness of the learning process. Positive perceptions of practical work can increase motivation to learn, active involvement, and overall understanding of physics concepts. Conversely, negative perceptions can be an obstacle in the learning process, especially if students feel that practical work does not provide real benefits or is less relevant to everyday life (Diyah et al., 2021; Ma'arif, 2016; Risnita & Bashori, 2020)

An analysis of students' perceptions of measurement practicums is needed to determine their impact on learning experiences, especially at the Madrasah Aliyah (MA) level, an important stage in laying the foundation for scientific thinking. This study used a qualitative approach to explore in depth how students interpret their experiences during the measurement practicum. The focus of this study is not only on learning outcomes but on how students understand, feel, and respond to practicum activities as part of the physics learning process (Sukino & Failasufah, 2019; Wahyuni, 2020). This study aims to explore in depth how students interpret measurement practicum activities in physics learning. This practicum helps students understand basic concepts, such as quantities, international units, the level of accuracy of measuring instruments, and measurement uncertainty. In addition, this activity helps develop science process skills, including the ability to observe, measure, analyze data, and draw conclusions from experimental results. Thus, practicum is not only a means to understand theory but also to practice essential scientific skills in physics learning (Darmaji et al., 2019; Dewi & Syafriani, 2024).

This study also examines the role of practicum as part of a constructivist approach, where direct experience with measuring instruments allows students to build conceptual understanding and scientific attitudes more meaningfully (Falentino et al., 2025;Lumbantoruan et al., 2019; Subekti & Ariswan, 2016) . Practicum is not only about data collection but also about training in analysis, problem-solving, and scientific reflection in the learning process. This study focuses on the analysis of students' perceptions of the measurement practicum in order to explore how experimental experiences can increase their involvement in physics learning. The results of this study are expected to provide strategic recommendations to improve the quality of measurement practicum implementation in Islamic high schools, thereby enhancing the effectiveness of physics learning and producing graduates with strong scientific skills.

Improving the quality of practicums not only affects the school level but also contributes to the development of more comprehensive, experience-based learning methods. The integration of technology, such as virtual laboratories and problem-solving-based approaches, allows students to explore physics concepts more flexibly and systematically (Kusmawan, 2024 ; Napirah & Safiuddin, 2024; Sriadhi et al., 2022). Thus, optimizing practicums directly impacts the broader transformation of physics, encouraging students to become more innovative individuals ready to face academic and professional challenges in the fields of science and technology.

METHODS

This study uses a qualitative approach with a qualitative descriptive type that aims to describe and analyze students' perceptions of the implementation of measurement practicums in physics learning (Astuti et al., 2025; Ruhansih, 2017). This approach was chosen because it allows researchers to explore students' subjective views in depth through direct interaction and the natural context of their learning environment. Thus, this approach is considered the most appropriate for understanding, holistically, the experiences and responses of Madrasah Aliyah (MA) students towards measurement practicum activities.

The study was conducted in two Islamic Senior High Schools in South Sulawesi, namely MA Muhammadiyah Datarang and MA 'Aisyiyah Sungguminasa Gowa. The location selection was carried out purposively based on the criteria that the madrasas had implemented measurement practicums in physics learning in the odd semester of the 2024/2025 academic year. The implementation time was adjusted to the learning schedule and the practicum implementation. The research subjects consisted of 41 students, namely 26 students from MA Muhammadiyah Datarang and 15 students from MA 'Aisyiyah Sungguminasa Gowa. The selected students had participated in measurement-practicum activities during physics lessons. The research sample was selected using a purposive sampling method based on specific criteria (Rahayu et al., 2025; Rini & Aldila, 2023).

Data were collected through several techniques, namely semi-structured interviews and observations. Interviews were used to explore students' perceptions, experiences, and opinions regarding measurement practicums. Interviews are reviewed as a method to explore in-depth perspectives from respondents through structured and unstructured interactions. Meanwhile, observations were carried out by paying attention to how students were involved in the practicum, including the use of measuring instruments and interactions during the practicum process (Lofland, 2017; Moleong, 2019; Sugiyono, 2020). In-depth interviews and observations were conducted during or after the practicum to examine students' attitudes and relationships. This study also includes documentation, including supporting materials such as practicum reports, modules, implementation notes, and photos of activities.

The main instrument in this study is the researcher himself as a human instrument, who plays a direct role in collecting, analyzing, and interpreting data, and is supported by interview guidelines and observation sheets. The interview guidelines contain open-ended questions arranged according to important aspects, including students' understanding of the objectives of the practicum, students' experiences during the practicum, perceptions of the benefits of the practicum in understanding the concept of measurement in physics learning, and practicum, obstacles faced during the practicum, and student suggestions for more effective implementation of the practicum (Arianto et al., 2024; Nurrisa et al., 2025).

The data were analyzed using thematic analysis techniques, which include several stages: data reduction, data presentation, and drawing conclusions (Mutmainna et al., 2025; Saunders et al., 2023; Sitasari, 2022). This process involves selecting and simplifying interview and observation data, grouping information by the main themes that emerge, and presenting the results descriptively to interpret students' perceptions of practical activities.

To ensure data validity, sources, techniques, and time were triangulated. Source triangulation was carried out by comparing data from interviews, observations, and documentation (Hadi, 2016; Wala & Tarumanagara, 2025). Triangulation was conducted using multiple data collection methods. Meanwhile, time triangulation was carried out by checking data at different times to obtain accuracy and consistency of information.

RESULTS AND DISCUSSION

This study involved a total of 41 students from two Islamic senior high schools in South Sulawesi, namely 26 students of MA Muhammadiyah Datarang and 15 students of MA 'Aisyiyah Sungguminasa Gowa. Based on the data analysis, students' perceptions of measurement practicums can be described in several main themes: conceptual understanding, learning experiences, benefits of practicums, and obstacles to implementing practicums.

Based on semi-structured interviews with Madrasah Aliyah students, it was found that measurement practicums play an important role in improving the quality of physics learning. 37 of 41 students reported that their understanding of measurement increased after participating in the practicum. However, some students still have difficulty with reading and measuring instruments precisely. All respondents showed a high interest in practicum activities. They expressed that learning became more interesting and contextual because it allowed active involvement and direct experience in using measuring instruments. The practicum was also considered highly relevant because it provided an opportunity to understand the tool's function in concrete terms.

This review demonstrates that practical activities can develop students' scientific understanding of how to perform accurate measurements. Thus, practicals not only deepen conceptual understanding but also develop science-process skills, which are crucial for physics learning. Overall, the results of this study indicate that practical activities are an effective learning method in supporting students' understanding of abstract concepts in physics, including measurement. Therefore, teachers are encouraged to provide adequate

opportunities for students to conduct simple experiments as part of active, meaningful learning (Waisakanitri et al., 2023; Zayrin et al., 2025).

However, the limited number of tools and practice time were the main obstacles students faced. Although there were no complaints about the tool's functionality, these limitations led to an uneven distribution of practice time among students. Regarding cooperation, most groups reported that communication and interaction during the practicum went well and were constructive. As a recommendation, all groups proposed increasing the number of practicum tools to enable activities to be implemented more efficiently and to provide a more equal learning experience for all students.

Interviews and student reflections indicated that laboratory activities played a significant role in deepening their understanding of measurement concepts. The majority of students revealed that prior to the lab, they were confused about the distinction between fundamental and derived quantities, standard units, and the importance of accuracy and proper reading of measuring instruments. The semi-structured interview assessment rubric is listed in Table 1.

Table 1 Semi-structured interview assessment rubric

Aspects Explored	Main Question	Probing Questions	Research result
Concept question	How is your understanding of the concept of measurement after participating in the practicum?	What is the easiest/most difficult thing about doing practical work?	37 out of 41 students stated that they understood the measurements better after the practicum than before. The difficulty is only in the accuracy of reading the measuring instrument precisely.
Interest and Enthusiasm	How do you feel when doing measurement practicums?	Are you interested or bored? Why?	All students answered that they were interested, citing a greater sense of challenge and a more authentic learning experience.
Relevance of Practicum	In your opinion, does this lab help in understanding the measurement material?	Can you explain which part was most helpful to you?	The most useful part, according to them, is being able to carry out measurements directly, as well as knowing the function of each measuring instrument.
Availability of Tools and Facilities	How do you assess the equipment and materials available during the practicum?	Is the equipment sufficient and functioning properly?	Considering the limited tools, they complained about the limited time each student had to complete the practical work; there were no problems with the tools' functionality.
Cooperation and Interaction	How was your experience collaborating in groups during the measurement practicum?	Is communication between group members going well?	5 groups from MA Datarang and three groups from MA Aisyiyah stated that communication was going well.

Aspects Explored	Main Question	Probing Questions	Research result
Obstacles or Constraints	What challenges did you face throughout the practicum?	How do you overcome these challenges?	The obstacles complained about were limited tools and time.
Suggestions and Hope	What are your recommendations for improving measurement practicums in the future?	What aspects would you like to add or change in the practicum implementation?	The aspect all groups requested was increased availability of practical tools to make implementation more efficient.

Concept Understanding

Based on the research results, the majority of students from both madrasahs stated that the practicum helped them understand the material about measurement more easily. As many as 22 out of 26 students from MA Muhammadiyah Datarang and 12 students from MA 'Aisyiyah Sungguminasa Gowa revealed that they previously had difficulty understanding the concept of measurement only from teacher explanations or textbooks. However, after participating in practicum activities and using the practicum tools directly, such as rulers, meters, scales, vernier calipers, screw micrometers, and digital scales, they felt they better understood the differences among the tools and how to use them. The following are the results of the study related to understanding the concept.

Some students even said that the mistakes that occurred during the practicum helped them understand the importance of paying attention to accuracy and the correct way to read measuring instruments. "When it was only explained on the board, my understanding was lacking, but after I held it and tried it myself, I began to understand how to read a vernier caliper," said one student from MA Muhammadiyah Datarang. Therefore, the analysis shows that the measurement practicum activities have a significant impact on improving students' understanding of measurement materials and enable them to connect abstract concepts with direct experience in physics learning. The following presents the results of research on the concept.

Based on interviews and analyses of responses from tenth-grade students at MA Aisyiyah Sungguminasa Gowa, the majority still struggle to understand the basic concepts of measurement in physics. Despite receiving explanations from teachers and reading textbooks, their conceptual understanding of measurement remains underdeveloped. 22 of the 26 students at MA Muhammadiyah Datarang and 12 at MA Aisyiyah Sungguminasa Gowa revealed that they previously struggled to understand measurement through teacher explanations or written materials. However, after participating in project-based learning activities or hands-on practice, they began to realize the importance of the concept.

One student stated, "At first, I thought measuring was just about looking at the numbers on the ruler, but after trying it out, I realized that how you look at the scale also plays a crucial role. If your eyes aren't aligned, the reading can be wrong." (Interview, X-MIPA 2 Student). This statement indicates that hands-on practice and a focus on the scientific method positively impact students' understanding. They increasingly recognize that measurement is not just about "using measuring instruments" but also involves precision, accuracy, and proper observation procedures.

Another student also stated, "In the past, I did not understand the difference between precision and accuracy. I assumed that if the values were close to what was expected, the instrument was good. But now, I realize that inconsistent results do not necessarily mean accurate results." (Interview, X-MIPA 1 Student). These findings are consistent with previous research showing that students often hold misconceptions about fundamental and derived concepts, SI units, and the uncertainty principle in measurement. This lack of understanding may be due to teaching methods that emphasize memorizing definitions rather than integrating practical skills and critical thinking.

From this analysis, purely theoretical measurement instruction tends to be less effective at developing students' conceptual understanding. Practical activities and experiment-based projects are more effective in raising students' awareness of the importance of precision and scientific procedures in measurement. Therefore, teachers are strongly encouraged to employ active, context-based learning strategies to deepen students' understanding of measurement concepts. Qualitative analysis of students' understanding of the concept of measurement is shown in Table 2.

Table 2 Qualitative analysis of students' understanding of measurement concepts

Category	Description of Findings	Data source	Number of Students
Understanding of accuracy in measurement	Students realize that accuracy is very important in physics experiments and learn to be more careful in reading the scales of measuring instruments after the practicum.	Student interviews	20 students from MA Muhammadiyah Datarang, 12 students from MA Aisyiyah Sungguminasa
Ability to use measuring tools	Practicums improve students' skills in using measuring instruments, especially in understanding the function and workings of instruments such as vernier calipers and micrometer screws.	Observation during practicum	22 students from MA Muhammadiyah Datarang, 13 students from MA Aisyiyah Sungguminasa
Difficulty in reading measuring instrument scales	Some students still experience difficulties in reading the instrument scale with high accuracy, so they need additional guidance from the teacher.	Student interviews and observations	10 students from MA Muhammadiyah Datarang, six students from MA Aisyiyah Sungguminasa
Scientific analysis of measurement results	Students are better able to analyze measurement data by comparing experimental results with the theories they have learned.	Student reflection notes after practicum	18 students from MA Muhammadiyah Datarang, 10 students from MA Aisyiyah Sungguminasa
Difficulty distinguishing physical quantities and units	Some students still struggle to identify physical quantities and units, indicating a need for additional practice in understanding basic measurement concepts.	Student interviews and assignment document analysis	12 students from MA Muhammadiyah Datarang, seven students from MA Aisyiyah Sungguminasa

Overall, the study's results indicate that the physics practicum has a positive impact on students' understanding of measurement, particularly in terms of accuracy, the use of measuring instruments, and the analysis of experimental results. Most students from MA Muhammadiyah Datarang and MA Aisyiyah Sungguminasa stated that direct experience with tools such as rulers, meters, scales, calipers, micrometer screws, and digital scales helped them better understand the function and level of accuracy of each tool than the lecture method. However, several obstacles remained, such as limited measuring instruments and limited practicum time, which reduced students' opportunities to explore concepts more deeply. Therefore, it is necessary to improve laboratory facilities and provide more active teacher guidance so that practicum can provide optimal benefits for understanding measurement concepts. If these improvements are implemented, physics practicum can be a more effective learning method in increasing student engagement, understanding, and motivation to learn (Muhlis et al., 2025; Nyirahabimana et al., 2023).

Statements from students from MA Muhammadiyah Datarang and MA Aisyiyah Sungguminasa revealed that measurement practicums helped them understand physics

concepts more concretely. This aligns with the constructivist theories of Piaget and Vygotsky, which emphasize the importance of direct experience in building understanding. In the context of practicums, students not only read theories but also observe and directly measure physics variables, including length, mass, time, and temperature, so that they can easily relate abstractions to reality (Azmin et al., 2021; Gunawan et al., 2018).

This finding is also supported by previous research, as noted by Sugiyono, which states that the learning model is an approach specifically designed to support the student learning process related to declarative knowledge and well-structured procedural knowledge, which can be taught through a gradual, step-by-step activity pattern. Sugiyono emphasized the importance of a structured learning model to support the student learning process (Ramadhani & Nurmalitasari, 2025; Sukadi, 2025). When the learning model is applied properly, students can follow the learning process more systematically, so that they not only remember information (declarative knowledge) but also apply the skills and steps needed in practice (procedural knowledge). This means their understanding deepens and becomes more comprehensive because they can see the relationship between theory and practice.

Learning experience

Most students consider that the practicum provides a more active, enjoyable, and less boring learning experience than the lecture method. Students feel more involved because they can work in groups, use measuring instruments, and discuss measurement-related topics. This shows that practicum not only improves understanding of the material but also contributes to learning motivation and students' positive attitudes towards physics lessons (Hayati et al., 2023; Yanti, 2021). Students feel more empowered in practicum because they can experiment and find their measurement results, which strengthens their sense of competence. Practicum is considered a variation of monotonous theoretical learning because it involves physical activity, group work, and problem-solving. The following is a description of the learning experience of students from MA Muhammadiyah Datarang and MA Aisyiyah Sungguminasa in Table 3.

Table 3 Qualitative analysis of students' learning experiences in physics practical work

Category	Description of Findings	Data source	Number of Students
Practical work increases motivation to learn physics	Students feel more enthusiastic about learning after the practicum because they can directly apply measurement concepts.	Student interviews	21 students from MA Muhammadiyah Datarang, 12 students from MA Aisyiyah Sungguminasa
Practical work is more fun than lecture methods	Students feel that practical work is more interesting and less boring than theoretical explanations in class.	Interviews and observations	22 students from MA Muhammadiyah Datarang, 13 students from MA Aisyiyah Sungguminasa
Understanding of measurement material after the practicum	Students better understand the concept of measurement after conducting direct experiments with various measuring instruments.	Student reflection notes	24 students from MA Muhammadiyah Datarang, 11 students from MA Aisyiyah Sungguminasa
Practicums help group work and discussion	Students find it easier to understand the material because they can discuss and work together in groups.	Observation during practicum	19 students from MA Muhammadiyah Datarang, 12 students from MA Aisyiyah Sungguminasa

Category	Description of Findings	Data source	Number of Students
Practicums increase students' interest in physics	Students are more interested in learning physics after participating in the practicum than before the experiment was conducted.	Student interviews	20 students from MA Muhammadiyah Datarang, 10 students from MA Aisyiyah Sungguminasa

The study found that physics practicums provided a more interactive and enjoyable learning experience than traditional lecture methods. Based on interviews and observations, most students reported being more motivated to learn physics after participating in practicums, as they could directly apply concepts and work in groups.

1. Practicum Increases Motivation to Learn Physics
   Students who previously felt less interested in physics subjects now show greater enthusiasm after participating in practicums. They feel that direct experiments help them understand the material better compared to just reading theories from books or listening to the teacher's explanations. A student from MA Muhammadiyah Datarang stated, "*I am more enthusiastic about learning physics because I can directly try the measuring instruments myself."*
2. Practicum is more fun than lectures.
   Most students said the practicum is more interesting than the lecture method because it provides a more active, less boring learning experience. Practicum allows students to take direct measurements, discuss with friends, and understand concepts through real experiences, which cannot be obtained from conventional lecture methods.
3. Understanding of Measurement Material After Practicum
   Practical work plays a major role in facilitating students' understanding of measurement material. Previously, many students found it difficult to differentiate physical quantities and units, as well as to read the scales of measuring instruments correctly. After the practicum, they better understand the functions of various measuring instruments such as rulers, three-arm scales, vernier calipers, and screw micrometers, and can better identify the level of accuracy of each instrument.
4. Practicums Encourage Collaboration and Group Discussion
   In addition to improving individual understanding, practicums also help students to collaborate and discuss with friends. In practicum sessions, students engage in active discussions, share assignments, and help each other in using measuring instruments. This creates a more collaborative learning atmosphere compared to one-way learning.
5. Practicum Makes Students More Interested in Learning Physics
   Practical work has a positive impact on students' interest and involvement in learning physics. They feel that physics becomes more interesting because the material can be applied directly, rather than just theoretical concepts that are difficult to understand. A student from MA Aisyiyah Sungguminasa said, "*I used not to like physics, but after the practicum, I understand it better and want to learn more."*

Overall, the results of the study indicate that practicums not only contribute to the understanding of physics concepts but also encourage students' learning motivation and positive attitudes towards the subject. Therefore, increasing the frequency and quality of practicums in physics learning can be an effective strategy to strengthen students' interest and engagement.

Benefits of Practicum

Practical activities aimed at improving conceptual understanding also help students develop science process skills, such as observing, recording data, and drawing conclusions. Some students even began to understand the importance of accuracy and scientific procedures in practical activities. As many as 25 students out of a total of 41 thought they would be more

careful in reading the scale of the measuring instrument and the measurement uncertainty they had previously ignored, because they remembered the importance of understanding the concept and the benefits of practical activities. Qualitative analysis of the influence of practical work on science process skills is shown in Table 4.

Table 4 Qualitative analysis of the influence of practical work on science process skills

Category	Description of Findings	Data source	Number of Students
Improving conceptual understanding through practical work	Students stated that through the practicum, they better understood the concepts of measurement and scientific principles applied in the experiments.	Student interviews	22 students from MA Muhammadiyah Datarang, 13 students from MA Aisyiyah Sungguminasa
Development of science process skills	Practicums help students develop skills such as observing, recording data, and drawing conclusions based on measurement results.	Observation during practicum	20 students from MA Muhammadiyah Datarang, 12 students from MA Aisyiyah Sungguminasa
Awareness of accuracy in measurement	After participating in the practicum, students begin to understand the importance of accuracy when reading the measuring instrument scale to avoid recording errors.	Student interviews	25 students out of a total of 41 students
Awareness of uncertainty in measurement	Some students recognize the uncertainty in measurements and begin to consider factors that influence the accuracy of experimental results.	Student reflection notes	18 students from MA Muhammadiyah Datarang, 10 students from MA Aisyiyah Sungguminasa
Benefits of practical work on scientific thinking skills	Students better understand that scientific procedures are essential in ensuring the validity of experimental results and avoiding systematic errors.	Interviews and class discussions	21 students from MA Muhammadiyah Datarang, 11 students from MA Aisyiyah Sungguminasa

The study found that physics practicums significantly contributed to students' understanding of concepts and science process skills. The practicum not only helped students better understand the concept of measurement but also developed scientific skills, such as observing, recording data, and drawing conclusions from measurement results. From interviews and observations, most students from MA Muhammadiyah Datarang and MA Aisyiyah Sungguminasa stated that they better understood the importance of accuracy in reading the scales of measuring instruments after participating in the practicum. Students began to realize that errors in reading the scale could cause uncertainty in the results of experiments, which they had previously often ignored.

In addition, the practicum encourages students to develop scientific thinking skills by understanding the procedures to be followed at each stage of the experiment. Student involvement in the practicum shows that they are beginning to understand the importance of the scientific method for obtaining accurate and valid data, as well as how measurement uncertainty can affect the results. Based on reflection after the practicum, many students

stated that they are now more careful in taking measurements and better understand the differences in the level of accuracy between measuring instruments (Nurrisa et al., 2025).

Although the practicum has provided many benefits, several aspects still need improvement to optimize its effectiveness. One thing that can be done is to improve teacher guidance in explaining scientific procedures and techniques for reading measuring instrument scales so that students can be more confident in conducting experiments. In addition, discussions about measurement uncertainty need to be strengthened so that students can better understand how external factors can affect their measurement results.

Thus, physics practicums have an important role in improving students' understanding of concepts and science process skills while forming a more systematic scientific mindset. If learning strategies continue to improve, practicums can be a more effective way to increase students' engagement, understanding, and motivation to learn physics.

Significant student involvement in the practicum was also seen. They felt actively involved in the learning process, either through group work, discussion, or data recording. This shows that the practicum supports collaborative and active learning, in line with the student-centered learning approach (Salsabila, 2024; Sørensen et al., 2023). The teacher's role also contributes to students' active involvement in the measurement practicum. This is evident from the observation that students from classes guided by teachers actively reported more meaningful practicum experiences than classes with minimal teacher guidance (Bardorfer, 2024; Mahliatussikah et al., 2022).

Implementation Constraints

In general, student perceptions were positive, but some obstacles were felt. The short practicum and the teacher's limited explanation during it were obstacles to understanding the entire process. In addition, the limited number of laboratory facilities and infrastructure, such as the lack of available measuring instruments, required some students to take turns using them. This shows that although the practicum is useful, its success is greatly influenced by the availability of adequate facilities and infrastructure and the use of good classroom management strategies. The open questionnaire rubric is listed in Table 5.

Table 5 Open questionnaire rubric

No	Question Rubric	Student Response
1	What do you think after undergoing the measurement practicum?	All students gave a positive response, saying they were more interested in learning with the practical method.
2	In what ways does this lab support your understanding of the measurement material?	By directly practicing how to take measurements with each tool and understanding that the tools' levels of accuracy vary, you also understand that their functions differ.
3	Please mention the part of the practicum that you consider most interesting and explain why!	Most students at MA Muhammadiyah Datarang said using the micrometer screw measuring tool was the most interesting, while at MA Aisyiyah, using a triple-arm balance was more interesting. All students were enthusiastic during the practical process.
4	What challenges or difficulties did you face during the practicum?	The limited number of tools is a complaint for most students, and this is also affected by the limited time they have to use them.
5	What are your recommendations for the implementation of physics practicums in the future?	The procurement of practical tools can be realized immediately.

The results of the study indicate that the physics practicum provides significant benefits for student understanding, but several obstacles affect its effectiveness. From interviews and observations, it is known that limited implementation time, limited measuring

instruments, and minimal teacher assistance are the main factors affecting students' learning experiences.

1. Short Practical Time
   Based on interviews with students and observations during the practical activities, many students reported that the available time was insufficient to understand the concept of measurement thoroughly. Some students felt rushed in completing the experiment, so they did not have the opportunity to repeat the measurement process or discuss the results obtained in more depth. One student from MA Muhammadiyah Datarang expressed that, "*We only have a short time to understand the measuring instrument. If there were more time, maybe we could understand the concept better."*
2. Limitations of Measuring Tools
   Another obstacle found was that the number of measuring tools available was not sufficient for all students. Observations showed that several groups had to take turns using tools such as rulers, calipers, and micrometer screws, limiting direct practice. One student from MA Aisyiyah Sungguminasa stated, "*We have to wait a long time to use the tools because the number is limited. Sometimes it is not optimal to understand how they work."*
3. Lack of Teacher Guidance
   Teachers' roles in practicums have a major impact on students' understanding of the experimental process. Based on interviews, several students felt that teachers did not provide in-depth guidance, especially in explaining how to read the scale of measuring instruments and the basic principles of measurement. This caused several students to become confused during practicums. A student from MA Muhammadiyah Datarang said, "*If the teacher explained more, maybe we would not have difficulty understanding the measurement results."*

This obstacle underscores the importance of technical training before the practicum and the need to strengthen literacy in the use of measuring instruments at the outset of learning. Another important thing is the allocation of sufficient time, and the availability of tools is an important factor to ensure the effectiveness of the practicum (Pratiwi, 2021).

Although the study's results show positive student perceptions of the measurement practicum, the discussion does not explicitly explain how the qualitative approach yielded these findings. Information was obtained through semi-structured interviews, direct observation during the practicum, and documentation of student reflections. This process allows researchers to capture subjective meanings formed by students based on direct experiences, such as difficulty reading the measuring instrument scale and feelings of understanding the concept better after the practicum. The qualitative approach not only records the number of respondents but also explores the narratives and contexts that accompany students' experiences. For example, students who stated that they understood the measurement better after holding the measuring instrument directly showed that sensory experiences and physical involvement influenced the construction of knowledge. This cannot be obtained solely from quantitative data.

Theoretically, the results of this study are supported by Vygotsky and Piaget's constructivist theories, which emphasize the importance of concrete experiences and social interactions in building understanding. The practicum acts as a scaffolding in physics learning, where students gain understanding through exploratory and collaborative activities. These findings emphasize that laboratory-based learning is very relevant in improving science process skills and understanding abstract concepts more meaningfully.

Thus, the qualitative approach not only enriches understanding of the practicum's effectiveness but also reveals significant differences from previous quantitative studies. This study contributes to the development of experiential learning strategies that support

modern learning theories and emphasize the importance of reflection, engagement, and social context in understanding basic physics concepts such as measurement.

CONCLUSION

The results of this study confirm that the measurement practicum plays an important role in strengthening the understanding of basic physics concepts at the Madrasah Aliyah level. Through direct involvement with measuring instruments such as rulers, calipers, and micrometer screws, students not only gain a deeper understanding of concepts but also develop science process skills and scientific attitudes, such as accuracy, curiosity, and responsibility. Practicum has been proven to bridge the gap between abstract learning and concrete experience while increasing students' learning motivation.

However, this study has several limitations. First, the scope of participants is limited to two madrasahs, which do not reflect the diversity of geographical contexts and facilities in other areas. Second, the qualitative approach used focuses on exploring perceptions without accompanying quantitative measurements of student learning outcomes. Third, the relatively short data collection period can limit the longitudinal depth of the dynamics of student perceptions.

The implications of these findings highlight the importance of improving laboratory facilities, increasing the number of measuring instruments, and providing more intensive teacher mentoring to achieve learning objectives optimally. The results of this study can also be a reference for curriculum developers and education policymakers in designing more effective practicum-based learning strategies. Further research using a mixed-methods approach and broader scope is recommended to gain a more comprehensive understanding of the impact of practicums on physics learning outcomes.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

AUTHOR CONTRIBUTIONS STATEMENT

Conceptualization, N and D; methodology, formal analysis, and original draft writing, EY; review and final editing. Authorship is limited to individuals who have made substantial contributions to this work.

ACKNOWLEDGMENT

Sincere appreciation is also extended to MA Aisyiyah Sungguminasa and MA Muhammadiyah Datarang for granting permission and providing the necessary facilities during the research process.

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