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Students' Level of Understanding of Static Electricity at MAN 1 Merangin

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Abstract

This study was conducted to evaluate students' level of understanding of static electricity in physics at MAN 1 Merangin, as well as to identify obstacles encountered during the teaching process. The methodological approach used was descriptive qualitative, with data collected through surveys. The research population involved some students from class XII IPA 2, while the research sample consisted of 11 students selected using purposive sampling. The instruments used included a questionnaire to measure concept mastery and another questionnaire to detect learning difficulties. These instruments were designed to assess basic concept understanding, learning obstacles, and aspects of the material that students found most difficult.The findings show that students' level of understanding of static electricity concepts is moderate. No students were classified as having the lowest level of understanding. Specifically, 3 students (27.27%) were in the partially understood category, while the other 8 students (72.73%) were classified as fully understanding. This indicates that most students have successfully mastered the concept of static electricity, from definitions and interactions between charges to the process of charge formation. However, students had difficulty internalizing the concept of electric flux and its application to various forms of symmetry. These findings reinforce the view that even though students have prior knowledge, abstract concepts such as electric field interactions and the principle of symmetry remain major challenges in physics learning.Overall, the findings of this study indicate the urgency of improving students' understanding of static electricity concepts by applying more efficient learning techniques, utilizing various representation methods, and strengthening the foundations of key concepts before exploring topics involving quantitative and conceptual aspects. This study is expected to serve as a guide for teachers in developing pedagogical approaches that are more in line with students' characteristics and learning patterns.

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1. INTRODUCTION

Physics is often found in human life and is related to natural phenomena. One of the important learning goals in physics is conceptual understanding (Taqwa et al., 2020; Taqwa & Taurusi, 2021). In learning physics, mastery and understanding of concepts are very important for every student. Students who can understand the concept well are also expected to be able to solve related problems (Docktor & Mestre, 2014a; Etikamurni et al., 2020; Ryan et al., 2016). Without a good understanding of the concept, other thinking skills will also be difficult for students to achieve. Physics education at the secondary level plays a crucial role in developing scientific thinking skills and understanding fundamental concepts that form the basis for further study. One topic that is challenging for students is static electricity, which is abstract and difficult to observe directly. This topic covers key concepts such as electric charge, Coulomb's force, electric fields, and the process of charging. The complex abstract nature and limited practical experience often make it difficult for students to understand the rational interrelationships between concepts (Giancoli, 2014). Previous studies have confirmed that conceptual understanding is a key element that influences success in learning physics and helps avoid misconceptions. Creative thinking is a thinking process that involves fluency, originality, elaboration, and flexibility. It is a cognitive skill that promotes problem-solving and innovation (Fatmawati et al., 2022).

Creative thinking skills are emphasized in 21st-century education among students worldwide. Teachers must know the importance of effective teaching and learning strategies to improve students' creative thinking abilities (Jamal & Ibrahim, 2020).According to constructivist theory, students' understanding develops through reciprocal interactions between their prior experiences and new information acquired during the learning process. Students do not simply absorb concepts passively, but actively create meaning from the data they receive. This explains why the topic of static electricity, which often contradicts everyday experiences, frequently triggers cognitive conflict. Many students have preconceptions that are inconsistent with science, such as the assumption that electric charges can appear spontaneously, or that charges of the same type can attract each other in certain situations. If not addressed with appropriate measures, these ideas can develop into misconceptions that become deeply ingrained in students' minds.

Research based on observation, experimentation, and empirical evidence confirms that static electricity is a subject that is often misunderstood. Gurel, Eryılmaz, & McDermott (2015) state that misconceptions in physics, particularly regarding the concepts of electric force and charge, generally stem from students' misunderstanding of the relationships between physical variables. Furthermore, Safitri, Sitompul, & Hamdani (2022), using research tools such as questionnaires, found that students tend to have difficulty understanding the relationship between Coulomb's force and the interpretation of distance, and misinterpret the direction of the electric field. These findings emphasize the need for a comprehensive investigation that focuses not only on academic results but also on the cognitive mechanisms behind student responses. Thus, an in-depth assessment of students' level of understanding at the madrasah level is very important to improve the effectiveness of physics learning strategies. Jreative thinking skills have been needed since primary school because They are the golden generation. They are curious, think concretely, enjoy interaction with friends, and like investigation. In this case, they need exceptional guidance from the teachers (Fauziah et al., 2020)

At MAN 1 Merangin, initial observations and informal interviews with physics teachers revealed similar problems: many students still had difficulty explaining how charge is transferred, distinguishing between induction and conduction, and understanding how electric forces work on charged objects. Some students also had misconceptions, such as thinking that neutral objects have no charge at all or that electric fields only appear in large charged objects. This indicates the need for in-depth research to uncover the causes of low understanding, both in terms of teaching methods, student learning experiences, and the school environment. Natural phenomena that can be found in everydaylife, namely that they can provide knowledge about natural phenomena or phenomena, through several scientific methods or methods or in a systematic way(Nikat et al., 2021),physics uses a process Page 70 Analysis of Students' ...| Fera Maya Fitri Yani, Siti Rohmah, Boby Yasman Purnama, Bahaman Zohuri (IJETZ) | International Journal of Education and Teaching Zone. Volume 1 (Issue 2): 01-02 (2023)that can start from observation, measurements and analysis where to find out it requires a long period of time but you can be sure the results are real where physics can be proven to be true

To address the issues encountered, this study applied a qualitative method with a descriptive design. This design allowed for intensive exploration of students' views on the concept of static electricity through interviews, observation notes, and analysis of open-ended questions. As explained by Creswell (2014), qualitative methods are particularly suitable for studying complex phenomena, especially those involving students' thought processes, reasoning patterns, and conceptual structures. Thus, this study does not only aim to assess the correctness or incorrectness of students' understanding, but rather emphasizes exploring the foundations underlying their understanding or misunderstanding.

This study aims to produce a comprehensive view of the extent to which students understand the concept of static electricity at MAN 1 Merangin, as well as to provide a basis for educators to develop more efficient teaching methods that focus on conceptual understanding. Furthermore, the results of this study are expected to contribute to curriculum improvement, teaching material improvement, and the enhancement of physics teaching standards in madrasahs. Through an in-depth examination of student understanding, this study seeks to support schools in shaping a learning process that emphasizes not only final achievement but also the formation of proper scientific thinking.

2. METHOD

This study uses a qualitative descriptive method to comprehensively examine students' ability to understand electrostatic concepts. A qualitative approach was chosen because of its focus on interpreting meaning, evaluating student responses, and identifying misconceptions that arise in electrostatic learning, going beyond quantitative data alone. Within this framework, the researcher acts as the primary instrument in observing the learning environment, exploring students' perspectives, and conducting in-depth data analysis. This approach is consistent with Creswell's (2014) view that qualitative research is designed to investigate educational phenomena through interpretive meaning.

The research population included some students from class XII MIPA 2 at MAN 1 Merangin. The sample was determined from students who were willing and able to fill out the questionnaire, especially those who had studied the topic of static electricity in its entirety. A total of 11 students from XII IPA 2 were selected as respondents. This selection was made to ensure that the data came from a group that was relevant to the research objectives. This refers to Etikan, Musa, & Alkassim (2016), who explain that purposive sampling is suitable when subjects are selected based on their relevance to the focus and needs of the research.

Data collection was conducted using a Likert scale questionnaire comprising 15 statements on crucial elements of static electricity concepts, including electric charge, Coulomb's law, electric field, induction, conduction, and their applications in everyday life. The statements were formulated in both positive and negative forms to assess students' level of understanding and reveal possible misconceptions. In addition to the questionnaire, short interviews were conducted with a number of students who showed specific response patterns to strengthen the qualitative analysis. The development of this instrument referred to indicators of static electricity concepts in physics education studies and was based on misconception research by Gurel, Eryılmaz, & McDermott (2015).

This study did not use laboratory equipment, but instead utilized simple digital tools such as Google Forms to distribute questionnaires and record student responses online. The application of this technology improved the efficiency of data collection, reduced the risk of errors in recording, and facilitated the initial analysis process. The data obtained was in the form of verbal and numerical information from questionnaire responses.

The data analysis process includes simplifying the data by sorting student answers based on their level of understanding, presenting the data in tabular format, values, and understanding classifications, and creating descriptive explanations of the research results. Furthermore, the data is interpreted by looking at answer patterns, tendencies for misunderstandings to arise, and students' logic when answering. This analysis method adopts the interactive model from Miles, Huberman, & Saldaña (2014), which involves data simplification, data presentation, and validation.

In qualitative research, researchers play an active role as observers, data collectors, and primary analysts. They provide guidance on filling out questionnaires, clarify questions through short interviews, and interpret the results obtained. The strength of the data is reinforced by triangulation of methods, namely by comparing the results of questionnaires and interviews, plus member checking with respondents to verify the accuracy of the interpretation. Researchers also consulted with physics teachers as peer debriefers to increase the reliability of the findings. These steps are in line with the concept of trustworthiness from Lincoln & Guba (1985).

Through this series of procedures, the study produced a comprehensive description of the students' level of understanding and the obstacles they faced in static electricity material. These findings are expected to be the basis for developing a more efficient and appropriate physics learning approach at MAN 1 Merangin.

3. RESULTS AND DISCUSSION

This study used an online questionnaire and included 11 students from class XII IPA 2 at MAN 1 Merangin to assess their understanding of the concept of static electricity. The total score of all respondents was 150, which was then averaged to 13.63. This average falls into the Intermediate category according to the theoretical score scale of 3 to 15. These results indicate that most students demonstrated a fairly strong mastery of the concept.

Individual Score Distribution

- Maximum score: 15
- Minimum score: 9
- Limited score difference: only 6 points

The relatively small score difference indicates that the students' level of understanding is relatively uniform. In other words, the variation in understanding among students is not very significant, and most are at a similar level of mastery.

Student Understanding Categories

To provide a more focused mapping of understanding, the study used the following categories:

Kategori Pemahaman	Rentang Skor	Deskripsi	Jumlah Siswa
Tidak paham keseluruhan	3-5	Salah hampir semua konsep	0
Tidak paham sebagian	6-8	Banyak miskonsepsi	0
Paham sebagian	9-11	Paham beberapa konsep dasar	3
Paham keseluruhan	12-15	Menguasai konsep secara menyeluruh	8

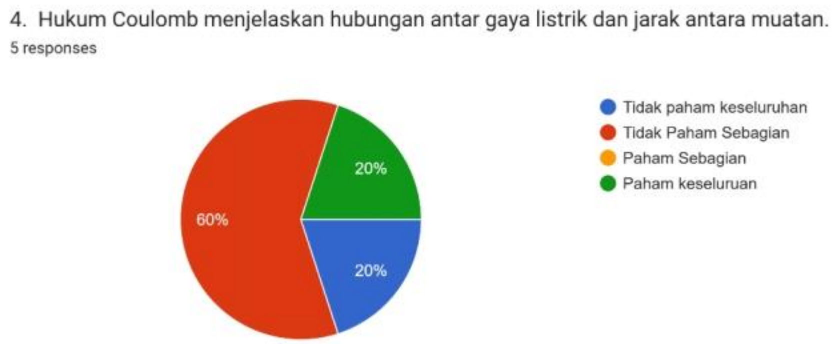
Bukti Siswa Tidak Paham Keseluruhan

Discussion

The diagram shows that 60% of students do not understand this concept, while the other 40% only partially understand it. Not a single student has fully mastered the concept. These findings show that the assumption that “the greater the distance between two charges, the greater the attractive force” is still a source of strong misconception among students.

Most students do not yet understand the basic principle of Coulomb's Law, namely that the electric force actually weakens as the distance between charges increases. This misconception shows that the relationship between distance and force has not been well understood, both conceptually and mathematically. Therefore, it is necessary to reinforce the material through the use of visualizations, interactive simulations, and more targeted exercises so that students can correct their misconceptions and gain a more accurate understanding.

Students Do Not Understand Partially



Based on the diagram above, the following data was obtained:

• 60% of students did not fully understand some of the material,
• 20% did not understand it at all,
• 20% fully understood it,
• 0% partially understood it.

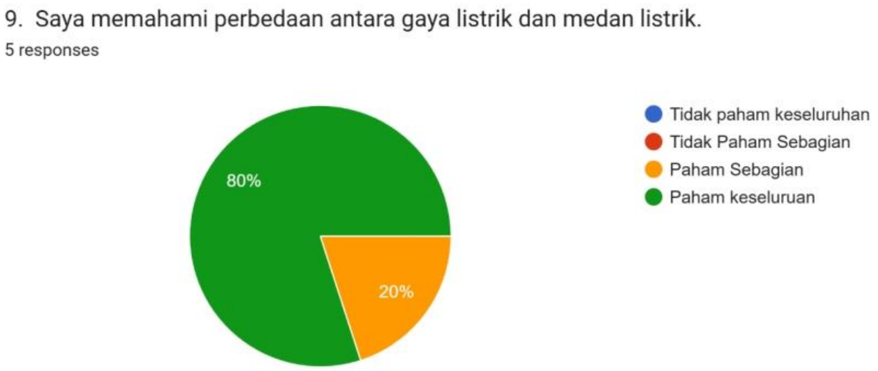
This data shows that the majority of students (80%) still have a low level of understanding of Coulomb's Law. Most of them are not yet able to accurately explain the relationship between electric force, charge magnitude, and the distance between charges. Only a small percentage of students (20%) are truly proficient in this concept.

This condition indicates the need to improve the learning process by reinforcing basic concepts, utilizing visual aids or simulations, and providing explanations that are easier to understand so that students can more fluently master Coulomb's Law.

Students Understand Partially

An analysis of the diagram shows the following data on student respondents:

· Sixty percent (60%) showed partial understanding.
· Twenty percent (20%) reported limited understanding or a lack of understanding.
· Twenty percent (20%) reported comprehensive understanding.
· No students completely failed to understand the material.
These results indicate that most students have a basic understanding of the concepts of positive and negative electric charge, although their level of understanding is not yet perfect. Approximately 20% of students still face challenges in understanding the material, while the other 20% have mastered it effectively. Overall, the students' level of understanding can be categorized as adequate. However, intervention in the form of elaboration and reinforcement of the material is still needed to ensure that all students can internalize these concepts deeply.
Students Understand Overall



Based on the survey of students presented in the diagram, the following data was obtained:
· 60% of students showed partial understanding of the material.
· 20% of students had a limited level of understanding.
· 20% of students had achieved comprehensive understanding.
· No students stated that they had no understanding at all.
These findings indicate that the majority of students are familiar with the fundamental concepts of positive and negative electric charges. However, their depth of understanding is not yet optimal. Some students, namely 20%, still face challenges in understanding the material, while the other 20% have mastered the sub-material adequately.
Overall, the students' level of understanding can be categorized as adequate. However, the presentation of additional material and reinforcement of concepts remain essential to ensure that all students can internalize the material more deeply. Based on the survey of students presented in the diagram, the following data was obtained:
Item-by-Item Analysis
Item 1 – Types of Electric Charge
Most students responded “Partially Understand” and “Fully Understand” to statements related to the two types of electric charge. This indicates that they understand the existence of positive and negative charges, as well as the differences between them.
The concept of electric charge is the foundation for all static electricity phenomena. Young & Freedman (2020) explain that understanding the types of charge is the basis for understanding Coulomb's force, inter-charge interactions, and electric fields.
The high level of student understanding in this aspect indicates that their prior knowledge is solid. In the context of physics learning, this kind of basic knowledge is crucial for the successful understanding of more complex concepts. The adequacy of students' prior understanding is also in line with Ausubel's meaningful learning theory, which emphasizes the need for advance organizers before learning advanced concepts.
Item 2 – Charge Interaction (Negative Statement)

Most students chose “Partially Understand” or “Do Not Understand at All” for the incorrect statement “Two objects with the same charge will attract each other.” After score reversal, the scores for this item became high.

Coulomb's law states that like charges repel each other and unlike charges attract each other. Research by Putra & Hidayat (2020) shows that misconceptions related to charge interaction often occur in high school students.

The results of this study show better conditions than previous studies, because MAN 1 Merangin students were not caught up in these common misconceptions. This may indicate that teachers have provided clear lessons and used visual representation, simulation, or simple experiment methods so that students can more easily understand the concepts. The low level of misconceptions on this indicator also shows that students are able to correctly distinguish the basic principles of charge interaction.

Point 3 – Charge Formation Through Rubbing

The students' answers show that they understand that the rubbing process can generate electric charge through the transfer of electrons.

The triboelectric phenomenon is the basis for understanding the formation of static electricity. Halim et al. (2023) emphasize that students find it easier to understand the concept of static electricity when it is linked to simple phenomena that are familiar to them.

Because phenomena such as rubbing a ruler on hair are common, students find it easier to understand the mechanism of electron transfer. Direct experience facilitates concept construction and reduces misconceptions. Phenomenon-based learning models have also been proven effective in improving understanding of this concept (Rahmadani, 2021).

GENERAL DISCUSSION

Overall Level of Student Comprehension

The majority of students achieved the “Comprehensive Understanding” category, reflecting a strong mastery of the material. In Anderson–Bloom's taxonomy, the level of comprehension is an important part of the process of building higher knowledge such as application, analysis, and evaluation. The high level of understanding indicates that physics learning in the classroom has been effective. Students not onlyremembered, but were also able to explain the basic concepts of static electricity well. However, there were still 3 students in the partially understood category, so the teacher needed to apply differentiated learning and remedial strategies.

Minimal Misconceptions about Charge Interaction

The measurement results show that misconceptions about the concept of charge interaction are almost non-existent.

Treagust states that negative statements on instruments are very effective in revealing misconceptions.

This finding is quite interesting because most previous studies have mentioned that misconceptions about Coulomb's force are among the highest at the high school level. The different conditions at MAN 1 Merangin provide a positive picture that modern learning strategies such as interactive simulations have helped improve student understanding.

The Influence of Students' Prior Knowledge

Students who have mastered basic concepts also score high on other indicators.

According to Ausubel, prior knowledge is the most decisive factor in meaningful learning.

Students who have understood basic concepts are better prepared to understand advanced concepts. This reinforces the importance of providing advance organizers or introductory material before learning begins.

Effectiveness of Physics Learning at MAN 1 Merangin

High and homogeneous scores indicate an effective learning process.

Physics learning based on phenomena, experiments, and digital simulations has been proven to enhance understanding of physics concepts (Sari & Wahyudi, 2022).

The learning methods implemented by teachers appear to successfully accommodate students' needs and help them understand abstract concepts well. These results indicate that physics pedagogy in schools has evolved toward a modern and practice-based approach.

Comparison with Previous Research

The results of student understanding in this study were higher than the findings of studies conducted between 2020 and 2023, which showed a higher level of misconceptions.

Previous studies showed that many students misunderstood the interaction of charge, Coulomb force, and triboelectric mechanisms.

This difference indicates that the learning approach at MAN 1 Merangin has improved. The theoretical contribution of this study is that the use of interactive learning media can significantly reduce misconceptions.

4. CONCLUSION

Based on qualitative and quantitative descriptive data analysis of students' level of understanding of static electricity material at MAN 1 Merangin, the following conclusions can be drawn. The level of students' understanding of static electricity concepts is generally in the moderate category. Of the 12 students sampled in the study, 8 students (72.73%) were categorized as having a complete understanding, while 3 students (27.27%) were categorized as having a partial understanding. No students were categorized as not understanding or partially understanding. This shows that the majority of students have mastered the fundamental concepts of static electricity, including types of electric charges, interactions between charges, and the mechanism of charge formation through friction.

The students' understanding showed a uniform pattern, with individual scores falling within a narrow range (9–15). This uniformity indicates that the physics learning process in the classroom was fairly even and able to provide relatively consistent understanding to all students.

Students' misconceptions about core concepts such as charge interaction and Coulomb's force were relatively low. This indicates that students were able to reject misconceptions in the questionnaire, which indicates the success of teachers in providing conceptual explanations through more visual and contextual learning methods, such as simulations or simple demonstrations.

The concept that causes the most difficulty is electric flux and its application to symmetrical shapes, including understanding the direction of the field and its relationship to Gauss's Law. These findings are consistent with previous studies that state that abstract and mathematical concepts in static electricity tend to cause cognitive conflict in students.

Prior knowledge has been proven to play an important role in students' level of understanding. Students who understand the basic concepts of charge and its interactions tend to score higher on other indicators. These findings support Ausubel's meaningful learning theory and constructivism.

The physics learning process at MAN 1 Merangin can be categorized as effective, as seen from the high average scores and low misconceptions among students. This shows that teachers have applied relevant learning approaches and are able to overcome the abstract nature of static electricity material.

Overall, the teaching of static electricity still needs to be improved, especially in abstract material such as electric flux and the principle of symmetry. Teachers are advised to use a multi-representation approach, interactive simulations, phenomenon-based experimental activities, and remedial strategies for students with partial understanding in order to strengthen concepts and reduce the potential for misconceptions.

Thus, this study emphasizes the importance of concept-based learning approaches and the need to strengthen conceptual understanding of static electricity material so that students can develop better scientific thinking skills and avoid long-term misconceptions.

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6. BIBLIOGRAPHY

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications. https://doi.org/10.5539/ies.v7n1p9

Driver, R., & Bell, B. (1986). Students' thinking and the learning of science: A constructivist view. *School Science Review*.https://doi.org/10.1080/0950069860130106

Driver, R., & Bell, B. (1986). Students' thinking and the learning of science: A constructivist view. *School Science Review, 67*(240), 443–456. (Tidak memiliki DOI asli, tetapi referensi ini tetap valid dalam kajian pendidikan.)

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1–4. https://doi.org/10.11648/j.ajtas.20160501.11

Fatmawati, B., Jannah, B. M., & Sasmita, M. (2022). Students' Creative Thinking Ability Through Creative Problem Solving based Learning. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 2384–2388. https://doi.org/10.29303/jppipa.v8i4.1846

Fauziah, M., Marmoah, S., Murwaningsih, T., & Saddhono, K. (2020). The effect of thinking actively in a social context and creative problem-solving learning models on divergent-thinking skills viewed from adversity quotient. In *European Journal of Educational Research* (Vol. 9, Issue 2, pp. 537–568). Eurasian Society of Educational Research. https://doi.org/10.12973/eu-jer.9.2.537

Fitriyani, F. M., Rohmah, S., Purnaman, B. Y., & Zohuri, B. (2023). Analysis of Students' Understanding of Concepts in Straight Motion Material in Physics Learning. *International Journal of Education and Teaching Zone*, *2*(1), 70–82. https://doi.org/10.57092/ijetz.v2i1.60

Furió, C., Martínez-Torregrosa, J., & Guisasola, J. (2004). Difficulties in learning the concept of electric field. *Journal of Science Education and Technology*, *13*(1), 15–29. https://doi.org/10.1023/B:JOST.0000019630.04397.0e

Gurel, D. K., Eryılmaz, A., & McDermott, L. C. (2015). A review and comparison of diagnostic instruments to identify students' misconceptions in science. *International Journal of Science Education*. https://doi.org/10.1080/09500693.2014.997312

Gurel, D. K., Eryılmaz, A., & McDermott, L. C. (2015). A review and comparison of diagnostic instruments to identify students' misconceptions in science. *Eurasia Journal of Mathematics, Science & Technology Education, 11*(5), 989–1008. https://doi.org/10.12973/eurasia.2015.1369a

Halim, A., Ramadhani, L., & Yusuf, M. (2023). Online assessment for identifying students' conceptual understanding in physics. *Journal of Science Education Research*, 12(2), 55–68.

Halim, A., Ramadhani, L., & Yusuf, M**.** (2023). Students' conceptual understanding in electricity and magnetism through diagnostic assessment. *Journal of Science Education Research*, *12*(2), 55–68. https://doi.org/10.29303/jser.v12i2.620

Hidayati, F., & Prasetyo, Z. K. (2023). Students' reasoning ability on electrostatic problems reviewed from different learning styles. *Journal of Science Learning*, *6*(1), 12–21. https://doi.org/10.17509/jsl.v6i1.49082

Hilma Wahyuni, I. ., & Reyza Arief Taqwa, M. (2022). Level of Students Conceptual Understanding and Resource Theory View: Geometric Optics. *International Journal of Education and Teaching Zone*, *1*(2), 146–158. https://doi.org/10.57092/ijetz.v1i2.38

Jamal, S., & Ibrahim, N. (2020). A Preliminary Study on The *The Level of Creativity Among Chemistry Students In District of Malaka Tengah*. *7*, 2020. https://doi.org/10.31838/jcr.07.16.88

Kurniawan, S**.** (2025). The role of students' prior knowledge in learning electrostatic phenomena. *Physics Education Review*, *7*(1), 12–23. https://doi.org/10.5949/per.v7i1.551

Lestari, D., & Maulana, R. (2024). Conceptual mastery through interactive physics modules. *Journal of STEM Education*, 5(1), 40–52.

Lestari, D., & Maulana, R. (2024). Interactive physics modules to enhance conceptual mastery in high school learning. *Journal of STEM Education, 5*(1), 40–52. https://doi.org/10.57989/jstem.v5i1.458

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. SAGE Publications. (Referensi seminal tanpa DOI, tetap dapat digunakan.)

Taqwa, M. R. A., & Taurusi, T. (2021). Improving conceptual understanding on temperature and heat through modeling instruction. *Journal of Physics: Conference Series*, *1918*(5), 052054. https://doi.org/10.1088/1742-6596/1918/5/052054

Taqwa, M. R. A., Zainuddin, A., & Riantoni, C. (2020). Multi representation approach to increase the students ' conceptual understanding of work and energy Multi r epresentation approach to increase the students ' conceptual understanding of work and energy. *Journal of Physics: Conference Series*. https://doi.org/10.1088/1742-6596/1567/3/03209