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# Correlation Between the Quality of *Free Body Diagram* and Students' Understanding of Physics Concepts about Newton's Laws

**Aprilla Rizki Maghfirah[1], Muhammad Nasir[1], Rusydi[1], Imam Wijaya[2]**
[1]Ar-Raniry State Islamic University, Banda Aceh, Indonesia
[2]Yoshida Kōgyō Kabushikigaisha Corporation, Tokyo, Japan

Correspondence: E-mail: muh.nasir@ar-raniry.ac.id

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**ABSTRACT**

This study aims to analyze the relationship between the quality of Free Body Diagram created by students and their understanding of Newton's Laws. This research employs a quantitative correlational method using a written test instrument and includes 40 eighth-grade students MTsS Lama Inong, Southwest Aceh Regency, using the purposive sampling technique. Data analysis was conducted using descriptive statistics, normality tests, linearity tests, Pearson correlation analysis, and significance tests. The results show that the average quality score of students' Free Body Diagram is 70.62, while the average conceptual understanding of physics is 60.87. The Pearson correlation test yielded a value of 0.900, with a t-value of 12.694, which is greater than the critical t-value of 2.024. The determination value of 0.804 indicates that the quality of Free Body Diagram contributes 80.4% to students' conceptual understanding. These findings demonstrate a very strong and significant relationship between the quality of Free Body Diagram created by students and their understanding of Newton's Laws. Therefore, the use of Free Body Diagram can serve as an effective instructional tool for enhancing students' conceptual. The implications of this study emphasize the importance of integrating visualization strategies in physics education to improve students' conceptual comprehension.



## 1. INTRODUCTION

Conceptual understanding of physics refers to students' ability to reproduce and apply physics principles and concepts accurately, rather than merely recognizing or memorizing theories (Ansumarwaty & Doyan, 2023)(Puspitasari et al., 2021). Physics studies natural phenomena physically, expressed in mathematical form and focusing on conceptual understanding (Maulidina & Bhakti, 2020). Understanding is a process in which students can interpret a problem by analyzing, demonstrating, classifying, formulating, concluding, comparing, and explaining (Loliyana et al., 2019). Therefore, understanding is a crucial aspect of both the learning process and daily life (Robbany Arham, Hilman. Galih Adirakasiwi, 2022). After learning fundamental concepts such as force, energy, and motion, students are expected to relate these concepts to real-life phenomena. Mastery of these concepts serves as an essential foundation for understanding theoretical principles and enhancing problem-solving skills in complex situations (Rohmani et al., 2015) (Agnesa & Sari, 2024).

The delivery of abstract concepts, such as Newton's Laws, in conventional learning is often suboptimal because lecture methods and reading materials are not always effective for all students(Arbaun et al., 2021). This approach makes it difficult to relate theory to real-world phenomena, resulting in a low level of understanding and application of physics principles (Y.H.M. Yusuf et al., 2022). The limitations of conventional teaching methods create a need for more interactive and creative approaches to enhance students' understanding of complex physics concepts, such as Newton's Laws. As a discipline requiring observation, measurement, and analytical skills, physics necessitates more interactive learning methods to deepen students' comprehension of complex concepts (Pranata & Lorita, 2023) (Ahmad et al., 2023).

One method that can enhance students' understanding of physics concepts is multi-representational learning, an approach that presents concepts through various formats such as words, diagrams, graphs, and symbols (Susilo, 2018). In physics, this approach helps students gain a deeper and more flexible understanding by utilizing multiple representations to reinforce conceptual mastery (Tajriyaani et al., 2020). Visual representations, such as *Free Body Diagram*, serve as essential tools in physics learning as they help students clearly understand force interactions within a system. *Free Body Diagram* enable students to illustrate, analyze, and break down the forces acting on an object, including determining their magnitude, direction, and type (Wayan Oka Wisnu Wardana, Salamang Salmiah Sari, 2024). Therefore, *Free Body Diagram* are highly useful in physics for comprehending and visualizing force interactions on a given object (Aini, 2020) (Robbany Arham, Hilman. Galih Adirakasiwi, 2022).

The multi-representational method helps students understand concepts in a diverse and in-depth manner, one of which is through physics learning using diagrams. *Free Body Diagram* representation is one method of presenting a concept in multiple forms ('Iffa et al., 2019). A *Free Body Diagram* is a visual representation that illustrates the forces acting on an object, making it easier to analyze and solve physics problems (Anisya et al., 2024). This diagram isolates an object and details all the forces acting upon it, which is known as a *Free Body Diagram* (Nurhayani et al., 2015). Through the use of *Free Body Diagram*, students are trained to draw, break down, interpret, and analyze the forces affecting an object, including determining the length, direction, and vector of forces, as well as naming each force. *Free Body Diagram* are highly beneficial in facilitating students' understanding of physics concepts, as this method can be applied in a more varied and in-depth manner. Furthermore, this method provides a clear depiction of force interactions, which are often difficult to explain through traditional lectures (Permana & Wayong, 2022).

Several previous studies have examined the role of *Free Body Diagram* in physics learning. Research conducted by Aisyah Mardini revealed that the use of *Free Body Diagram* has a significant impact on students' ability to solve problems related to Newton's Laws (Mardini et al., 2018). Galuh Utami also found that proficiency in representing *Free Body Diagram* contributes to the understanding of Newton's Second Law, with a coefficient of determination of 43.6% (Utami et al., 2013).

Furthermore, a study by Syamsinar Pase indicated that students have a fairly good ability to solve structured essay questions involving *Free Body Diagram*. Meanwhile, Ogi Danika Pranata discovered a positive correlation between the use of arrow symbols in *Free Body Diagram* and students' understanding of the concept of force, with a Pearson correlation coefficient of 0.611. (Yanitama & Listiaji, 2023)

Although numerous studies have examined the effectiveness of *Free Body Diagram* in physics learning, there are still research gaps that need further exploration. Unlike previous studies that focused more on the impact of using *Free Body Diagram* on technical skills and problem-solving, this study emphasizes how the quality of diagrams produced by students can reflect their overall understanding of physics principles. Additionally, this study investigates the extent to which visual aspects and diagram representation influence students' comprehension of physics concepts.

Preliminary observations through interviews with science teachers at MTsS Lama Inong revealed that students' skills in drawing and analyzing problem-solving involving forces remain low. Many students make errors in representing the forces acting on an object, which hinders their understanding of Newton's Laws and negatively affects their learning outcomes. To test this assumption, this study formulates the hypothesis that there is a significant relationship between the quality of *Free Body Diagram* and students' conceptual understanding of Newton's Laws (Ha). Meanwhile, the null hypothesis (Ho) states that there is no significant relationship between these two variables. Understanding this correlation is expected to contribute to the development of more effective visual representation-based learning strategies. This study aims to analyze the relationship between the quality of *Free Body Diagram* and students' conceptual understanding of Newton's Laws. The findings of this research are expected to have implications for the development of more interactive physics teaching methods and to enhance students' understanding of fundamental physics concepts.

## 2. METHODS

This study employs a correlational research design to analyze the extent to which the investigated variables are related to or influence one another in the context of Newton's Laws. The variables in this study are the quality of the *Free Body Diagram* and the understanding of physics concepts. The research was conducted at MTsS Lama Inong Southwest Aceh Regency. The study population includes all students at MTsS Lama Inong, with a sample representing all eighth-grade students.

The instrument used in this study is a written test consisting of five questions that assess both the quality of the *Free Body Diagram* and the understanding of physics concepts. Students were asked to draw a *Free Body Diagram* and explain the concept for each question. The instrument has undergone a validation process by two experts and one physics teacher. In this study, data collection was carried out through written tests.

As shown in Table 1, the scoring guidelines are provided for assessing students' responses regarding the quality of the *Free Body Diagram* and their understanding of physics concepts. The data were measured using a scale of 1 to 4 and then converted to a scale of 1 to 100 before the correlation analysis. This conversion allows for easier comparison and interpretation in the context of processing students' responses.

**Table 1.** Research Rubric

| Variable | 1 (Missing) | 2 (Inadequate) | 3 (Need Improvement) | 4 (Adequate) |
|---|---|---|---|---|
| Quality of Free-Body Diagram. | Does not create a free-body diagram. | Creates a free-body diagram, but contains major errors such as incorrect vector magnitude or direction, extra vectors, or missing vectors. | Creates a free-body diagram without errors in vector magnitudes but lacks labels and is not drawn from the correct reference point. | Creates an accurate free-body diagram with correctly labeled vectors, making each vector representation clear. |
| Physics Concept Understanding | Does not answer the conceptual understanding question. | Answers the question but contains errors in selecting the correct physics law, miscalculations, or | Answers the question with relevant but incomplete responses or minor errors, such as notation mistakes, slight numerical miscalculations, or | Answers the question correctly with complete step-by-step solutions and includes appropriate physics representations, such as diagrams, graphs, |

| | | | | |
|---|---|---|---|---|
| | | ignoring important factors. | minor errors in scientific language. | or mathematical expressions. |

The correlation test used in this study is the Pearson correlation test. This test is conducted if the data are normally distributed and there is a linear relationship between the two variables, which can be verified using SPSS analysis. These two tests serve as prerequisites for performing the Pearson correlation test. The correlation test results are expressed using the correlation coefficient (r), which ranges from -1 to +1. A positive r value indicates a direct (positive) relationship, whereas a negative r value indicates an inverse (negative) relationship. An r value of 0 signifies no linear relationship between the two variables. To interpret the strength of the correlation coefficient obtained, researchers can refer to Table 2, which provides guidelines for interpreting the r values. This table serves as a reference for determining the strength of the relationship between the variables based on the obtained r value.

**Table 2.** Correlation Coefficient Values

| Correlation Coefficient Interval | Relationship Strength |
|---|---|
| 0,00 – 0,199 | Very Low |
| 0,20 – 0,399 | Low |
| 0,40 – 0,599 | Moderate |
| 0,60 – 0,799 | Strong |
| 0,80 – 1,000 | Very Strong |

## 3. RESULT AND DISCUSSION

This study was conducted at MTsS Lama Inong with a population comprising all students of the 2024/2025 academic year, and a sample of 40 eighth-grade students determined based on Isaac and Michael's table with a 5% margin of error. The aim of this study is to examine the correlation between the quality of *Free Body Diagram* and students' conceptual understanding of Newton's Laws. The analysis was carried out by assessing students' ability to draw *Free Body Diagram* and their understanding of relevant physics concepts.

The data were analyzed using descriptive statistics to observe distribution, median, and mean. The results of this analysis were used to identify patterns in the relationship between the two variables before further analysis was conducted using appropriate statistical methods.

**Table 3.** Descriptive Statistics

| | N | Min. | Maks. | Mean |
|---|---|---|---|---|
| Quality of Free-Body Diagram | 40 | 35.00 | 95.00 | 70.6250 |
| Physics Concept Understanding | 40 | 25.00 | 85.00 | 60.8750 |
| Valid N (listwise) | 40 | | | |

In Table 3, it can be seen that all collected data are valid. The results indicate that the average score for *Free Body Diagram* quality is higher than the average score for students' conceptual understanding of physics. This suggests a potential relationship between students' ability to visually represent physical situations and their level of understanding of physics concepts.

Before conducting further correlation analysis, the data underwent prerequisite statistical tests. The normality test results confirmed that the data were normally distributed, while the linearity test indicated a linear relationship between the *Free Body Diagram* quality and students' conceptual understanding of physics. Thus, the data meet the necessary assumptions for further statistical analysis.

The next assumption, which states that the relationship between the two variables is proven to be linear, is supported by the scatterplot shown in Figure 1.

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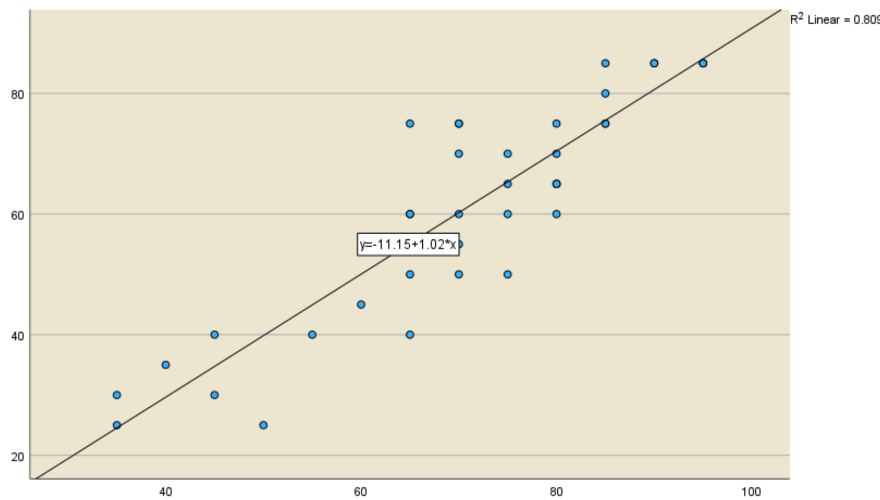


**Figure 1.** Pearson Correlation

In the scatter plot diagram (Figure 1), it can be observed that the data points are clustered diagonally between the x-axis and y-axis. This indicates a strong positive relationship between the quality of *Free Body Diagram* and students' understanding of physics concepts. The accumulation of points along the diagonal suggests a correlation between improved diagram quality and deeper conceptual understanding of physics.

Based on these results, it can be concluded that an increase in the ability to draw *Free Body Diagram* is directly related to an improvement in conceptual understanding of physics. This highlights the importance of visual representation in physics learning.

This correlation test was analyzed using the *Pearson Product Moment* equation with the assistance of *SPSS version 25* software.

**Table 4.** Correlation Test Results**

| | | Quality of Free-Body Diagram | Physics Concept Understanding |
|---|---|---|---|
| Quality of Free-Body Diagram | Pearson Correlation | 1 | .900** |
| | Sig. (2-tailed) | | <.001 |
| | N | 40 | 40 |
| Physics Concept | Pearson Correlation | .900** | 1 |

| | | | |
|---|---|---|---|
| Understanding | Sig. (2-tailed) | <.001 | |
| | N | 40 | 40 |

**. Correlation is significant at the 0.01 level (2-tailed).

Based on the data in Table 4, the calculated *r* value or *Pearson Correlation* is 0.900 with p < 0.001. Since the significance value is less than 0.05, the correlation is considered *statistically significant*. This result indicates a very strong correlation, falling within the range of 0.80–1.00, which signifies a perfect positive relationship between the two variables.

To test the significance of this correlation, a t-test was conducted. This test aims to determine whether the quality of the *Free Body Diagram* has a significant effect on students' understanding of physics concepts. If the significance value (p-value) is less than 0.05, the relationship is declared significant. To test this hypothesis, if $t_{hitung} \leq t_{tabel}$ then $H_0$ is accepted, and if $t_{hitung} > t_{tabel}$ then $H_a$ is *accepted*. The test results can be seen in Table 5 below.

**Table 5.** t-Test Results*

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -11.152 | 5.811 | | -1.919 | .063 |
| | Quality of Free-Body Diagram | 1.020 | .080 | .900 | 12.694 | <.001 |

*Dependent Variable: students' understanding of physics concepts

Based on Table 5, the obtained significance value (sig) is 0.001, which is less than 0.05, indicating that the relationship between the variables is significant. To determine $t_{tabel}$ the degrees of freedom dk = n - 2 = 40 - 2 = 38 at a 5% 0,05 significance level. Based on this calculation $t_{tabel}$ is 2,024 Since the result shows that $t_{hitung} > t_{tabel}$ is 12,694 > 2,024 $H_a$ is accepted.

Correlation analysis can be continued by calculating the coefficient of determination, which is the square of the correlation coefficient (r). In this study, the obtained correlation coefficient is 0.900.

**Table 6.** Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .900[a] | .809 | .804 | 7.937 |

a. Predictors: (Constant), *Free Body Diagram* Quality

Based on the output, the coefficient of determination (Adjusted R Square) was found to be 0.804, indicating that the quality of the *Free Body Diagram* influences students' understanding of physics concepts by 80.4%. Meanwhile, the remaining 19.6% is influenced by other factors not examined in this study.

These results demonstrate that the relationship between the quality of the *Free Body Diagram* and the understanding of physics concepts is statistically significant. In other words, students' ability to draw *Free Body Diagram* is an essential predictor of their comprehension of physics concepts. This relationship occurs because the *Free Body Diagram* serves as a visual aid that helps students model abstract physics concepts, particularly in Newton's Laws. By using *Free Body Diagram*, students can represent the forces acting on an object more clearly, making it easier for them to understand how these forces influence an object's motion.

Additionally, the process of drawing a *Free Body Diagram* encourages students to think analytically in identifying and determining the direction of relevant forces. This process not only enhances their understanding of physics concepts but also helps them solve physics problems more systematically. Students who can accurately draw *Free Body Diagram* tend to have better problem-solving skills because they can grasp essential information before proceeding with further calculations.

Furthermore, the use of *Free Body Diagram* also helps reduce conceptual errors that often occur in understanding forces and their interactions. Mistakes in determining the direction of forces or forgetting the forces acting on an object can be minimized by using this visual representation. Thus, students can develop a more accurate understanding of the physics concepts being studied. From a cognitive theory perspective, visual representations such as *Free Body Diagram* can enhance memory retention and conceptual understanding. These diagrams connect verbal information with visual information, strengthening students' comprehension of complex physics concepts. Therefore, the better students are at drawing *Free Body Diagram*, the higher their understanding of physics concepts, as demonstrated in the findings of this study.

Based on the research findings, these results align with previous studies. According to a study by Aisyah Mardini, the implementation of *Free Body Diagram* has a significant effect on students' ability to solve Newton's Laws problems. A similar study by Galuh Utami stated that skills in representing *Free Body Diagram* influence students' understanding of Newton's Second Law, with an impact of 43.6%, as indicated by the coefficient of determination (R Square). This is consistent with research conducted by Syamsinar Pase, which showed that students' ability to solve structured descriptive problems involving *Free Body Diagram* falls into a fairly good category. Additionally, a study by Ogi Danika Pranata found a strong positive correlation between arrow notation and the quality of *Free Body Diagram*, obtaining a Pearson correlation coefficient of 0.611.

Unlike other studies that focus on the influence of *Free Body Diagram* on problem-solving skills, this research emphasizes how the quality of diagrams produced by students reflects their overall understanding of physics principles.

## 4. CONCLUSION

Based on the research and data analysis, there is a significant relationship between the quality of the *Free Body Diagram* created by students and their understanding of physics concepts in Newton's Laws. This is demonstrated by the Pearson Correlation value of 0.900 with a significance of $p < 0.001$, indicating a strong positive relationship. Additionally, the calculated $t_{hitung}$ of 12,694 is much greater than the $t_{tabel}$ 2,024 or 12,694 > 2,024. Thus, $H_a$ is accepted, confirming a significant relationship between the variables. The higher the quality of the *Free Body Diagram* created by students, the better their understanding of physics concepts, particularly Newton's Laws.

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## REFERENCES

‘Iffa, U., Supriana, E., & Sutopo, S. (2019). Kesalahan Siswa Dalam Mengidentifikasikan dan Menggambarkan Diagram Gaya. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *4*(7), 844. https://doi.org/10.17977/jptpp.v4i7.12612

Agnesa, O. S., & Sari, F. (2024). Pengembangan Modul Praktikum IPA Berbasis Keterampilan Proses

Sains pada Program Studi PGMI. *Jurnal Basicedu*, *8*(1), 643–650. https://doi.org/10.31004/basicedu.v8i1.7074

Ahmad, M. S., Rahayu, Y. S., & Sukarmin, S. (2023). Training Scientific Literacy Skills Through Inquiry Learning with Chemcollective's Virtual Laboratory on Chemical Equilibrium. *JPPS (Jurnal Penelitian Pendidikan Sains)*, *12*(2), 155–175. https://doi.org/10.26740/jpps.v12n2.p155-175

Aini, S. and F. . (2020). Efektivitas Pembelajaran dengan Diagram Benda Bebas pada Hukum Newton secara Terintegrasi untuk Meningkatkan Penguasaan Konsep Siswa. *JRPF (Jurnal Riset Pendidikan Fisika)*, *5*(1), 12–17.

Anisya, N., Sutarsana, S., Widyawati, T., Hidayat, T., & Mahmudah, I. R. (2024). Analisis Penggunaan Free Body Diagram ( FBD ) Pada Materi Hukum Newton. *Frekuensi*, *1*.

Ansumarwaty, F., & Doyan, A. (2023). Analysis of the Feasibility and Effectiveness of Ethnoscience-Based Science Learning Tools for Improving Students' Science Literacy: A Review. *AMPLITUDO : Journal of Science and Technology Inovation*, *2*(2), 119–124. https://doi.org/10.56566/amplitudo.v2i2.98

Arbaun, M., Makahinda, T., & Lolowang, J. (2021). Pengembangan Media Pembelajaran Interaktif Menggunakan Lectora Pada Materi Hukum Newtion Tentang Gerak. *Charm Sains: Jurnal Pendidikan Fisika*, *2*(1), 49–52. https://doi.org/10.53682/charmsains.v2i1.79

Loliyana, N., Sukamto, G. M., & Andayani, E. S. (2019). Pengaruh Model Outdoor Learning terhadap Pemahaman Sejarah Mahasiswa Pendidikan Sejarah. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *4*(6), 803. https://doi.org/10.17977/jptpp.v4i6.12536

Mardini, A., Djamas, D., & Putra, A. (2018). Dampak Penerapan Free Body Diagram Terhadap Kemampuan Peserta Didik Menyelesaikan Soal-Soal Hukum Newton Dalam Pembelajaran Fisika SMA. *Pillar of Physics Education*, *11*(2), 65–72.

Maulidina, S., & Bhakti, Y. B. (2020). Pengaruh Media Pembelajaran Online Dalam Pemahaman Dan Minat Belajar Siswa Pada Konsep Pelajaran Fisika. *ORBITA: Jurnal Kajian, Inovasi Dan Aplikasi Pendidikan Fisika*, *6*(2), 248. https://doi.org/10.31764/orbita.v6i2.2592

Nurhayani, Mansyur, J., & Darsikin. (2015). Kualitas Diagram Benda Bebas Buatan Siswa Dalam Physics Problem Solving. *Jurnal Sains Dan Teknologi Tadulako*, *4*, 28–35.

Permana, I., & Wayong, M. (2022). *PENGEMBANGAN MODUL PRAKTIKUM FISIKA DASAR 1 TERINTEGRASI AYAT AL- QUR ' AN Development of Practicum Module of Basic Physics 1 Integrated Version of the Qur ' an*. *2*(1), 79–86. https://doi.org/10.24252/al-khazini.v2i1.31489

Pranata, O. D., & Lorita, E. (2023). Analisis Korelasi Kemampuan Berbahasa Panah Dengan Kualitas Free-Body Diagram Siswa Pada Materi Dinamika. *Jurnal Pendidikan Fisika Dan Sains (JPFS)*, *6*(1), 22–31. https://doi.org/10.52188/jpfs.v6i1.394

Puspitasari, R., Mufit, F., & Asrizal. (2021). Conditions of learning physics and students' understanding of the concept of motion during the covid-19 pandemic. *Journal of Physics: Conference Series*, *1876*(1). https://doi.org/10.1088/1742-6596/1876/1/012045

Robbany Arham, Hilman. Galih Adirakasiwi, A. (2022). Analisis Kemampuan Pemahaman Matematis Siswa Dalam Menyelesaikan Soal Matematika Dasar. *Didactical Mathematics*, *4*(2), 314–322. https://doi.org/10.31949/dm.v4i2.2148

Rohmani, Sunarno, W., & Sukarmin. (2015). Pengembangan Media Pembelajaran Fisika Berbasis Multimedia Interaktif Terintegrasi Dengan LKS Pokok Bahasan Hukum Newton Tentang Gerak Kelas X SMA/MA. *Jurnal Inkuiri*, *4*(1), 152–162.

Susilo, S. (2018). Pengaruh Pembelajaran Multirepresentasi Berbantuan Multimedia Terhadap Perubahan Jenis Representasi Siswa. *Jurnal Penelitian Pendidikan IPA*, *2*(1), 11. https://doi.org/10.26740/jppipa.v2n1.p11-18

Tajriyaani, A., Lallo, J., Sinaga, P., & Utari, S. (2020). INVENTORY PEMAHAMAN GRAFIK DAN KEMAMPUAN REPRESENTASI KONSEP FISIKA SISWA SMP PADA POKOK BAHASAN KINEMATIKA. *WaPFi (Wahana Pendidikan Fisika)*, *5*(2), 1–5.

Utami, G., Suyanto, E., & Abdurrahman, A. (2013). The Influence of Free-body Diagram Representation

Skill Towards the Concept Comprehension. *Jurnal Pembelajaran Fisika Universitas Lampung*, *1*(1).

Wayan Oka Wisnu Wardana, Salamang Salmiah Sari, K. A. (2024). ANALISIS KEMAMPUAN REPRESENTASI FREE BODY DIAGRAM PADA MATERI HUKUM NEWTON. *Jurnal Sains Dan Pendidikan Fisika (JSPF)*, *1*, 35–45.

Y.H.M. Yusuf, K.A. Astiti, H.F. Lalus, & T. Haba. (2022). Analisis Kesulitan Siswa Dalam Menyelesaikan Soal-Soal Fisika Menggunakan Teori Polya Pada Materi Fluida Dinamik. *Jurnal Pendidikan Dan Pembelajaran IPA Indonesia*, *12*(3), 140–146. https://doi.org/10.23887/jppii.v12i3.54706

Yanitama, A., & Listiaji, P. (2023). *Jurnal Penelitian Pendidikan Development of the Practicum Guide e-module Basic Physics for Practice Student Science Process Skills*. *40*(1), 1–6.