



Systematic Literature Review: Analysis of Students' Reasoning Ability and Difficulties in Newton's Law Material

Nur Azizah¹, Lia Yuliati^{2*}, Khusaini²

¹Physics Education Study Program, Universitas Negeri Malang, Malang, Indonesia.

²Physics Department, Universitas Negeri Malang, Malang, Indonesia.

Received: January 17, 2025

Revised: March 20, 2025

Accepted: May 25, 2025

Published: May 31, 2025

Corresponding Author:

Lia Yuliati

lia.yuliati.fmipa@um.ac.id

DOI: [10.29303/jppipa.v11i5.10433](https://doi.org/10.29303/jppipa.v11i5.10433)

© 2025 The Authors. This open access article is distributed under a (CC-BY License)



Abstract: This study aims to identify students' reasoning abilities and learning difficulties related to Newton's Laws through a systematic literature review using the PRISMA method. The review analyzes seven scientific articles published between 2020 and 2024 in SINTA-accredited journals, international conference proceedings, and Scopus-indexed sources. The findings indicate that students' reasoning abilities regarding Newton's Law are still low, with an average conceptual understanding of only 33.3%. Common difficulties faced by students include interpreting Newton's First Law (inertia and constant velocity), understanding the relationship between force, mass, and acceleration in the Second Law, and the action-reaction principle in the Third Law. These difficulties are generally caused by the abstract nature of the concepts and students' weak logical reasoning skills. The review also highlights the need for effective instructional strategies. Contextual teaching, problem-solving-based learning models, and metaphorical thinking approaches are proposed as potential solutions. These strategies are considered effective in enhancing students' conceptual understanding and scientific reasoning abilities when implemented appropriately. The findings provide valuable insights for educators to design more targeted instructional interventions and contribute to improving learning outcomes in physics education, particularly in Newtonian mechanics.

Keywords: Difficulty; Literature review; Newton's laws; Reasoning ability

Introduction

The challenges of 21st-century education demand that students not only master concepts but also be able to develop their thinking skills. Thinking skills go beyond simply memorizing material and formulas; they involve fostering creativity, critical thinking, scientific reasoning, and problem-solving abilities (Bariyyah, 2021; Rios et al., 2020). One of the essential skills in today's era is strong reasoning ability (Cano et al., 2023).

Reasoning ability is one of the key competencies required in the 21st century (Abate et al., 2021). It plays a crucial role in enabling students to develop critical thinking skills to analyze and solve problems (Xu et al.,

2022). With good scientific reasoning, students can objectively evaluate information, draw logical conclusions, and make accurate decisions based on data and evidence (Zulkipli et al., 2020). This is highly relevant to facing the complex real-world challenges in the era of globalization (Ningrum et al., 2024).

Research on reasoning abilities in various physics topics has shown that these abilities remain relatively low. For instance, Isnawati et al. (2024) found that students' scientific reasoning skills on dynamic fluid topics, particularly in proportional reasoning indicators, were mostly categorized as TM (no answer), indicating that students struggled with making comparisons. Another study by Sundari & Rimadani (2020) on

How to Cite:

Azizah, N., Yuliati, L., & Khusaini. (2025). Systematic Literature Review: Analysis of Students' Reasoning Ability and Difficulties in Newton's Law Material. *Jurnal Penelitian Pendidikan IPA*, 11(5), 50-55. <https://doi.org/10.29303/jppipa.v11i5.10433>

temperature and heat topics showed that many students remained in the intuitive category for proportional reasoning, providing correct answers without appropriate or logical scientific justifications. Furthermore, a study by Yana et al. (2021) on Newton's Law revealed that students' scientific reasoning abilities, based on all Lawson indicators, were in the low category due to the lack of constructivist-based learning approaches.

Another common issue faced by students is difficulty in problem solving (Hijriani & Hatibe, 2021). Additionally, students often exhibit low logical and argumentative abilities, resulting in answers that only state the final result without any supporting explanation of the process (Rosdianto, 2018). Previous research by Khoirina et al. (2018) highlighted the use of inappropriate instructional approaches and methods, which failed to adequately train students' reasoning skills directly.

The diversity of students' difficulties and reasoning abilities on Newton's Law material encouraged researchers to conduct a literature study on this issue. The purpose of this study is to describe students' reasoning abilities and difficulties regarding Newton's Laws. This research was conducted by collecting relevant articles discussing reasoning skills and learning difficulties. The selected articles span the last five years, from 2020 to 2024, and were published in SINTA-accredited journals, international conferences, or Scopus-indexed publications. The results of this study are expected to provide concise information that compiles findings from similar studies on students' reasoning abilities in Newton's Law topics. This research can serve as a reference for developing solutions to address students' reasoning challenges in learning Newton's Laws.

Method

This study uses a Systematic Literature Review (SLR) approach following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to identify and analyze articles related to students' reasoning abilities and learning difficulties in Newton's Laws material (Putri et al., 2025). The review process consists of four main stages: identification, screening, eligibility, and inclusion.

Identification

The article search was conducted using the Publish or Perish software and manual searches through several academic databases, namely Scopus, ScienceDirect, ERIC, and Google Scholar. The publication range was limited to the years 2020 to 2024, with articles written in

Indonesian or English and focused on physics education.

The search used the keywords in various combinations: Newton's laws, scientific reasoning ability, students' reasoning skills, learning difficulties, physics education, high school physics.

Screening

After duplicates were removed, the remaining articles were screened based on titles and abstracts to assess their relevance to the research objectives. Articles that did not focus on Newton's Laws or did not address students' reasoning abilities and learning difficulties were immediately excluded.

Eligibility

Articles that passed the screening stage were analyzed in full to ensure they met the inclusion criteria. The inclusion criteria were: Discusses students' reasoning abilities and/or learning difficulties in Newton's Laws; Presents empirical research (quantitative or qualitative); Published in accredited journals or reputable conference proceedings; Context of the study is within high school physics education.

Articles were excluded if: The main focus was not on Newton's Laws; It was a theoretical paper without empirical data; It did not assess or discuss reasoning skills or learning difficulties.

Inclusion

A total of seven articles that met all inclusion criteria were selected for analysis. The analysis focused on the types of reasoning abilities investigated, the forms of learning difficulties experienced by students, and the instructional strategies proposed to address these issues.

The data analysis in this study followed the Systematic Literature Review (SLR) approach guided by the PRISMA methodology. The process began with thoroughly reading each article that met the inclusion criteria, followed by classifying the content based on three main aspects: the types of reasoning abilities examined, the types of learning difficulties students experienced, and the instructional strategies used or proposed in each study. After classification, the findings from each article were compared and synthesized to identify consistent patterns as well as differences across studies. To maintain the validity and reliability of the analysis, several systematic steps were taken. First, source triangulation was carried out by comparing and confirming findings across multiple articles to ensure consistency of information. Second, inclusion and exclusion criteria were applied strictly and consistently to avoid subjective bias in article selection.

Result and Discussion

Students' Reasoning Ability and Difficulties

Analysis of students' reasoning ability and difficulties by summarizing the results of various articles

in a table to determine students' reasoning ability and difficulties in each study conducted. For more details, it is presented in Table 1.

Table 1. Tabulation of article analysis

Authors	Result
Yana et al. (2021)	The results revealed that the Transitional Mode (TM) category dominated most of the students' scientific reasoning (SR) patterns. The most mastered SR pattern is Probabilistic Thinking (PBR), while the least mastered pattern is Hypothetical-Deductive Reasoning (HDR). Overall, 33% of students were at the concrete operational stage, 53% were at the transitional stage, and only 14% reached the formal operational stage. Based on these findings, it is concluded that the pattern and level of students' scientific reasoning ability in Newton's Law material is still relatively low.
Utami et al. (2020)	Students' scientific reasoning skills on the application of Newton's Laws show mixed results, with the Correlational Reasoning indicator 61% in the good category, but Probabilistic Reasoning 24.8% and Proportional Reasoning 14.2% still require more attention to improve students' understanding and reasoning skills. This indicates the need for improvement in teaching strategies to encourage students' concept understanding and logical thinking skills.
Syarqiy et al. (2023)	The results showed that students' reasoning ability on Newton's Law material before the intervention was given was low. Many students had difficulty in connecting everyday phenomena with the concept of Newton's Law, such as normal force, gravitational force, and action-reaction law.
Hijriani & Hatibe (2021)	Most students are at a moderate level of difficulty in solving physics problems on Newton's Law of motion material. The average percentage of students who experienced difficulties reached 61.11%.
Syaidah et al. (2023)	The results of this study revealed that students experienced various difficulties in solving Newton's law of motion problems. These difficulties appeared at all stages of problem solving according to Polya's theory (understanding the problem, planning a solution, implementing the plan, and reviewing the solution).
Iswandayani et al. (2024)	Students showed difficulty in understanding basic concepts, such as force as a pull or push. Some students were confused by the relationship between force, mass and acceleration (Newton's Law II). This confusion caused them to be unable to answer the questions correctly.
Azzahidah et al. (2024)	This study shows that students in grade XI SMA have high difficulty in understanding Newton's Law, with an average score of only 33.3% (very low category). The greatest difficulty was in analyzing the forces acting on objects (18.2% correct answers). Students had difficulty understanding the concept of constant velocity (Law I), the relationship between acceleration and force (Law II), and the action-reaction principle (Law III).

The results of the analysis of 7 research articles show that the ability to reason on newton's law material tends to be low and there are still many difficulties in understanding the material. Various difficulties are also shown in the research results, as for ways or solutions in overcoming the problem will be explained in the results of section 2.

Solutions to Overcome Reasoning Ability and Student Difficulties

Contextual Approach

The Contextual Teaching and Learning (CTL) approach is a learning concept that connects subject matter with students' real-world situations, so that students can understand the material more deeply and relevantly. This approach encourages active student involvement by linking the knowledge they have with its application in everyday life (Lestari et al., 2021). One of the important characteristics of this approach is experiential learning, where students not only learn the theory but also apply the concepts through real activities such as measurements, experiments, or simulations

(Rohman & Perdana, 2024). In addition, CTL encourages collaboration and interaction between students in group discussions, and motivates them to make connections between the knowledge they learn and its application in their family, community and society (Milanto et al., 2023). By doing meaningful activities, students are not only able to understand math concepts but also build critical, creative and analytical thinking skills (Nainggolan & Purwaningsih, 2024). For example, in area and perimeter learning, students can be asked to calculate the area of a school field or garden so that they understand how these concepts are relevant in real life. This approach also increases students' motivation as learning feels more relevant to their daily lives (Zaharah & Silitonga, 2023).

Problem Solving Model

The Problem Solving Learning Model is a method that prioritizes students' skills in solving problems through a series of systematic steps. This model not only teaches theory but also trains students to think critically, analytically, and creatively in finding solutions (Rasyid

et al., 2025). Polya (1973) outlines four main stages in problem solving, namely understanding the problem, developing a plan, implementing the plan, and re-examining the results. The first stage, understanding the problem, involves students in recognizing the information given and determining what needs to be solved (Amalia & Ratnaningrum, 2025). Next, they develop a plan by choosing the appropriate method or strategy to solve the problem (Widayati & Sofwan, 2025). After that, students execute the plan that has been made carefully and finally recheck the solution to ensure its accuracy. This approach gives students the opportunity to explore various alternative solutions, so that they can understand concepts in depth and develop reasoning skills. For example, the teacher can assign the task of calculating travel costs by considering different modes of transportation, which requires an analysis of time, distance and cost. This model not only helps students develop logical and analytical skills, but also trains them to face real-world challenges with confidence (Karanggulimu, 2021).

Metaphorical Approach

The metaphorical thinking approach has a significant positive impact on students' reasoning ability. Based on research, this approach helps students understand abstract concepts by comparing them with more concrete and relevant things from everyday life. With this approach, students are invited to use metaphors in solving problems, which allows them to connect mathematical concepts with real experiences, so that learning becomes more meaningful. Therefore, the metaphorical thinking approach can be considered as an effective method to improve mathematical reasoning ability, especially in understanding and solving contextual problems (Eliza et al., 2023).

Reasoning ability is an important part of learning. This is explained in the research of Anjani et al. (2020) not only a deep understanding of Newton's law but students must also have good reasoning skills. The results of the analysis of 7 articles show that students' reasoning skills still tend to be low and experience various difficulties. These difficulties arise influenced by various things. As in the research of Syaidah et al. (2023) students have difficulty in solving problems and understanding newton's law.

This difficulty usually arises because this law requires not only understanding theoretical concepts but also mathematical applications in solving problems. Newton's three laws include fundamental principles about the motion of bodies, the interaction of forces, and the relationship between mass and acceleration. Although these principles seem simple, students often have difficulty relating them to real situations or complex problems. Research by Mufidah et al. (2020)

proves students often memorize Newton's laws without really understanding them. For example, Newton's Second Law ($F = ma$) is understood as a mathematical formula, but students do not understand how force, mass, and acceleration interact with each other in a physical context.

Various efforts are needed to solve the problem of reasoning ability on newton's law material. Solutions that can be done are contextual approaches and problem solving, these two things complement each other in improving students' reasoning skills. The contextual approach creates relevant and meaningful learning, while the problem solving model trains students to apply their knowledge in solving real problems, thus forming critical, systematic, and creative thinking skills (Eliza et al., 2023). Based on the findings of the achievement of reasoning skills and students' difficulties in Newton's law material, it encourages improvement innovation. Analysis of 7 articles shows that opportunities can be made to improve reasoning skills and overcome difficulties. Efforts that can be made are changing the approach in accordance with the context of the material to be taught. This information can be used by teachers to make improvements according to the difficulties experienced and consider the effectiveness of each effort.

Conclusion

This study aimed to describe students' reasoning abilities and learning difficulties in Newton's Law material through a systematic literature review using the PRISMA method. Based on the analysis of seven selected articles published between 2020 and 2024, it was found that students' reasoning abilities remain low, particularly in aspects such as hypothetical-deductive reasoning, proportional reasoning, and probabilistic thinking. The average understanding of Newton's Laws concepts among students was only 33.3%. Specific difficulties were identified in interpreting Newton's First Law (inertia and constant velocity), understanding the quantitative relationship between force, mass, and acceleration in the Second Law, and applying the action-reaction principle in the Third Law. These challenges are largely due to the abstract nature of the material and the lack of effective, reasoning-oriented learning approaches. To address these issues, several strategies were identified, including contextual learning, problem-solving models, and metaphorical thinking approaches, all of which have the potential to enhance students' scientific reasoning and conceptual understanding when implemented effectively. The findings of this study imply that teachers need to design learning interventions that are more targeted and conceptually grounded, in order to support students in overcoming

reasoning barriers and improve their overall comprehension of Newtonian mechanics.

Acknowledgments

The author would like to express sincere gratitude to Mrs. Lia Yuliati, the first academic advisor, for her valuable guidance, constructive feedback, and continuous support throughout the completion of this study. Special thanks are also extended to Mr. Khusaini, the second academic advisor, for his insightful suggestions and encouragement that greatly contributed to the quality and direction of this research.

Author Contributions

N.A. contributed to the preparation of the original draft, including the results, discussion, methodology, and conclusion sections; L.Y. and K. responsible for proofreading, reviewing, and editing the manuscript.

Funding

This research received no external funding.

Conflicts of Interest

There is no conflict of interest in this article.

References

- Abate, T., Michael, K., & Angell, C. (2021). Upper Primary Students' Views Vis-à-Vis Scientific Reasoning Progress Levels in Physics. *Eurasia Journal of Mathematics, Science and Technology Education*, 17(5), 2-15. <https://doi.org/10.29333/ejmste/10834>
- Amalia, L., & Ratnaningrum, I. (2025). The Effect of Problem Based Learning Model and Differentiation Approach on the Results of Natural and Social Science Learning of Grade V Students. *Jurnal Penelitian Pendidikan IPA*, 11(4), 81-93. <https://doi.org/10.29303/jppipa.v11i4.10935>
- Anjani, F., Supeno, S., & Subiki, S. (2020). Kemampuan Penalaran Ilmiah Siswa SMA dalam Pembelajaran Fisika Menggunakan Model Inkuiri Terbimbing Disertai Diagram Berpikir Multidimensi. *Lantanida Journal*, 8(1), 13. <https://doi.org/10.22373/lj.v8i1.6306>
- Azzahidah, M., 'Abidah, Kusairi, S., Hanatan, A., & Hariyanto, H. (2024). Analisis Kesulitan Siswa SMA Pada Materi Hukum Newton Menggunakan Instrumen Force Concept Inventory (FCI). *Jurnal Penelitian Pembelajaran Fisika*, 15(1), 7-17. <https://doi.org/10.26877/jp2f.v15i1.14990>
- Bariyyah, K. (2021). Problem Solving Skills: Essential Skills Challenges for the 21st Century Graduates. *Jurnal EDUCATIO: Jurnal Pendidikan Indonesia*, 7(1), 71. <https://doi.org/10.29210/120212843>
- Cano, J. C., Lomibao, L., & Lomibao, L. S. (2023). A Mixed Methods Study of the Influence of Phenomenon-Based Learning Videos on Students' Mathematics Self-Efficacy, Problem-Solving and Reasoning Skills, and Mathematics Achievement. *American Journal of Educational Research*, 11(3), 97-115. <https://doi.org/10.12691/education-11-3-2>
- Eliza, R., Sepriyanti, N., & Ulfah, H. (2023). Penerapan Pendekatan Berpikir Metaforis Terhadap Kemampuan Penalaran Matematis Siswa. *Mathema Journal*, 5(2), 82-92. <https://doi.org/10.33365/jm.v5i2.2678>
- Hijriani, H., & Hatibe, A. (2021). Analisis Kesulitan Belajar dalam Memecahkan Masalah Fisika pada Materi Hukum Newton Tentang Gerak. *JPFT*, 9(1), 45-49. <https://doi.org/10.22487/jpft.v9i1.788>
- Isnawati, I., Sandi, M., Werdhian, I. K., & Giorgadze, I. (2024). Scientific Reasoning Ability of Class XI Students of SMA Negeri 1 Sindue Tombusabora on Dynamic Fluid Matter. *EduFisika Jurnal Pendidikan Fisika*, 9(2), 247-255. <https://doi.org/10.59052/edufisika.v9i1.36833>
- Iswandayani, H., Jalaludin, A. A., Apriliana, G., & Kurniawati, W. (2024). Identifikasi Kesulitan Belajar Siswa Sekolah Dasar dalam Memahami Konsep Hukum Newton 3 pada Mata Pelajaran IPA. *COLLASE (Creative of Learning Students Elementary Education)*, 7(3), 520-526. <https://doi.org/10.22460/collase.v7i3.21852>
- Karanggulimu, Y. (2021). Upaya Meningkatkan Hasil Belajar Fisika dengan Pendekatan Pembelajaran Problem Solving pada Siswa Kelas XI Mipa 4 SMA Negeri 1 Maumere. *Journal on Teacher Education*, 3(1), 85-93. <https://doi.org/10.31004/jote.v3i1.2702>
- Khoirina, M., Cari, C., & Sukarmin, S. (2018). Identify Students' Scientific Reasoning Ability at Senior High School. *Journal of Physics: Conference Series*, 1097(1). <https://doi.org/10.1088/1742-6596/1097/1/012024>
- Lestari, F. P., Ahmadi, F., & Rochmad, R. (2021). The Implementation of Mathematics Comic Through Contextual Teaching and Learning to Improve Critical Thinking Ability and Character. *European Journal of Educational Research*, 10(1), 497-508. <https://doi.org/10.12973/EU-JER.10.1.497>
- Milanto, S., Suprpto, N., & Budiyanto, M. (2023). Effectiveness of Contextual Learning Using the Guided Inquiry Approach to Improve Students' Scientific Literacy Ability. *Jurnal Penelitian Pendidikan IPA*, 9(1), 444-448. <https://doi.org/10.29303/jppipa.v9i1.2785>
- Mufidah, J., Parno, P., & Diantoro, M. (2020). Penguasaan Konsep Siswa dalam Argument Driven Inquiry Berbasis Fenomena Disertai Penilaian Formatif. *Briliant: Jurnal Riset Dan Konseptual*, 5(4), 749. <https://doi.org/10.28926/briliant.v5i4.516>
- Nainggolan, E., & Purwaningsih, D. (2024). Identifying

- Collaboration Skills Through Discovery Learning with A Contextual Approach. *Jurnal Penelitian Pendidikan IPA*, 10(4), 1739-1746. <https://doi.org/10.29303/jppipa.v10i4.6943>
- Ningrum, W. T., Handayani, D. R., & Maryani, M. (2024). Investigasi Kemampuan Bernalar Ilmiah Siswa melalui Implementasi Model Problem Based Learning Materi Fisika Fluida Statis. *JPF (Jurnal Pendidikan Fisika) FKIP UM Metro*, 12(1), 68-80. <http://dx.doi.org/10.24127/jpf.v12i1.9433>
- Polya, G. (1973). *How to Solve It: A New Aspect of Mathematical Method*. New Jersey, USA: Pricenton University Press.
- Putri, R. A., Parno, P., & Taufiq, A. (2025). Effectiveness of Innovative Learning Models to Improve Scientific Reasoning on Physics Topics: A Literature Review. *Journal of Research in Science Education*, 11(3), 19-22. <https://doi.org/10.29303/jppipa.v11i3.10197>
- Rasyid, F., Jumadi, J., & Hawur, P. K. (2025). How to Improve Multiple Representation Skills in Physics Learning: A Systematic Literature Review. *Journal of Science Learning*, 8(1), 25-40. <https://doi.org/10.17509/jsl.v8i1.76514>
- Rios, J. A., Ling, G., Pugh, R., Becker, D., & Bacall, A. (2020). Identifying Critical 21st-Century Skills for Workplace Success: A Content Analysis of Job Advertisements. *Educational Researcher*, 49(2), 80-89. <https://doi.org/10.3102/0013189X19890600>
- Rohman, F., & Perdana, R. (2024). The Development of Learning E-Modules Based on Contextual Teaching and Learning on the Material of Changing the Form of Energy to Improve Students' Science Literacy. *Jurnal Penelitian Pendidikan IPA*, 10(8), 6095-6103. <https://doi.org/10.29303/jppipa.v10i8.8323>
- Rosdianto, H. (2018). Peningkatan Keterampilan Berpikir Kritis Siswa Melalui Penerapan Model Generative Learning pada Materi Hukum Newton. *JIPFRI (Jurnal Inovasi Pendidikan Fisika dan Riset Ilmiah)*, 2(2), 49-55. <https://doi.org/10.30599/jipfri.v2i2.211>
- Sundari, P. D., & Rimadani, E. (2020). Peningkatan Penalaran Ilmiah Siswa Melalui Pembelajaran Guided Inquiry Berstrategi Scaffolding pada Materi Suhu dan Kalor. *Jurnal Eksakta Pendidikan (JEP)*, 4(1), 34. <https://doi.org/10.24036/jep/vol4-iss1/402>
- Syaidah, L., Afgani, M. W., & Sairi, A. P. (2023). Eksplorasi Kesulitan Belajar Siswa dalam Menyelesaikan Masalah Hukum Newton Tentang Gerak. *Al'Ilmi*, 12(1), 1-5. Retrieved from <http://jurnal.radenfatah.ac.id/index.php/alilmi/article/view/18455>
- Syarqiy, D., Yuliati, L., & Taufiq, A. (2023). Exploration of Argumentation and Scientific Reasoning Ability in Phenomenon-Based Argument-Driven Inquiry Learning in Newton's Law Material. *Jurnal Penelitian Pendidikan IPA*, 9(9), 7264-7272. <https://doi.org/10.29303/jppipa.v9i9.4589>
- Utami, D. S., Muharrami, L. K., Hadi, W. P., & Ahied, M. (2020). Profil Scientific Reasoning Ability Siswa Pada Materi Gerak Benda. *Quantum: Jurnal Inovasi Pendidikan Sains*, 11(2), 93. <https://doi.org/10.20527/quantum.v11i2.8570>
- Widayati, T. U., & Sofwan, M. (2025). The Influence of the Implementation of the Integrated PBL (Problem Based Learning) Model with Differentiated Learning on Students' Critical Thinking Skills in Science Subjects. *Jurnal Penelitian Pendidikan IPA*, 11(4), 364-371. <https://doi.org/10.29303/jppipa.v11i4.10669>
- Xu, W., Geng, F., & Wang, L. (2022). Relations of Computational Thinking to Reasoning Ability and Creative Thinking in Young Children: Mediating Role of Arithmetic Fluency. *Thinking Skills and Creativity*, 44(May), 101041. <https://doi.org/10.1016/j.tsc.2022.101041>
- Yana, A. U., Handayanto, S. K., & Wuryanti, T. (2021). Eksplorasi Kemampuan Scientific Reasoning Materi Hukum Newton Siswa SMA. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 6(4), 503. <https://doi.org/10.17977/jptpp.v6i4.14694>
- Zaharah, Z., & Silitonga, M. (2023). Meningkatkan Kreativitas Peserta Didik Melalui Model Pembelajaran Berbasis Proyek (Project Based Learning) di SMP Negeri 22 Kota Jambi. *Biodik*, 9(3), 139-150. <https://doi.org/10.22437/biodik.v9i3.28659>
- Zulkipli, Z. A., Yusof, M. M. M., Ibrahim, N., & Dalim, S. F. (2020). Identifying Scientific Reasoning Skills of Science Education Students. *Asian Journal of University Education*, 16(3), 275-280. <https://doi.org/10.24191/ajue.v16i3.10311>