Journal of Innovative Physics Teaching
Volume 4, Issue 1 June 2026, 99 – 110
ISSN: 3021-8551 (Online)
Doi: https://doi.org/10.24036/jipt/vol4-iss1/124
https://jipt.ppj.unp.ac.id/index.php/jipt

Need Analysis and Context to Develop Motion Dynamics E-Student Worksheet Integrated Problem Solving Model to Improve Student's Problem Solving Skills

Siti Aisyah Lubis[1*], Selma Riyasni[2], Hidayati[3], Renol Afrizon[4]
[1,2,3,4] Department of Physics, Padang State University, Padang, Indonesia.

Article Info

Article history:

Received April 17, 2026
Revised June 11, 2026
Accepted June 15, 2026

Keywords:

Electronic worksheets
Problem Solving
Dynamics of Motion
Problem Solving Skills
Needs Analysis

ABSTRACT

This research is driven by the limited problem-solving abilities of students in motion dynamics and the inadequate integration of digital learning resources that support such skills. The urgency of this study lies in the increasing demand for 21st-century learning that emphasizes problem-solving skills, critical thinking, and the integration of digital technology in physics education. However, current instructional materials used in schools are still largely conventional and have not effectively facilitated structured problem-solving processes. Therefore, this study aims to examine the needs and contextual basis for developing a problem-solving-oriented electronic student worksheet to foster students' problem-solving competence. A qualitative descriptive method was employed, involving needs analysis through observations and questionnaires distributed to both students and teachers. The findings indicated that students required more interactive learning materials, real-life problem contexts, and guided problem-solving stages to better understand physics concepts. Teachers also expressed the need for practical digital resources that are easy to implement in classroom instruction and capable of supporting independent learning. These results provide an empirical foundation for the development of an electronic worksheet that aligns with curriculum objectives, learner characteristics, and technology-enhanced learning environments, while promoting active engagement and meaningful conceptual understanding for students across different levels of prior knowledge.

***Correspondence:**
Siti Aisyah Lubis, Department of Physics, Padang State University, Padang, Indonesia.
· email : sitiaisyahlubis0102@gmail.com , Phone: 082179365715

INTRODUCTION

Twenty first century, physics education requires students not only to memorize formulas and concepts but also to apply them in solving real-world problems systematically and analytically. This demand aligns with the global educational focus on higher-order thinking skills, including problem-solving, critical thinking, and collaboration (Sukaesih et al, 2022; Li et al, 2021)). Problem-solving skills are essential because they help students analyze situations, develop solutions, and evaluate outcomes critically (Muslimin, M., & Purwaningsih, 2023). In physics learning, these skills support students in understanding natural phenomena and relating concepts to everyday life. However, the 2022 PISA report shows that Indonesian students' scientific literacy remains below the OECD average, indicating limited ability to apply scientific knowledge in real-life contexts (OECD, 2023). Therefore, innovative and well-structured physics instruction is needed to improve students' problem-solving abilities.

Dynamics of motion is an important topic in high school physics that examines the relationship between forces and changes in an object's motion. The topic includes concepts such as Newton's Laws, friction, weight, and normal force, which require both conceptual understanding and mathematical analysis in real-life situations. However, many students still experience difficulties in understanding force concepts and applying them to motion problems that require scientific reasoning (Wardhani, U. K., & Setyarsih, 2021). Students often struggle to identify relevant variables, develop mathematical models, and interpret solutions meaningfully in everyday contexts.. A study by Silvianti et al, (2022) also found that students tend to understand motion concepts separately and have difficulty applying them holistically in complex situations. Therefore, instructional approaches that support structured problem-solving processes are needed to help students develop systematic thinking skills.

Students' difficulties in physics problem-solving are influenced by several interconnected factors related to students, teachers, and learning materials. Many students are still unfamiliar with structured problem-solving stages, such as identifying problems, planning strategies, implementing solutions, and evaluating results, as explained by Polya (Rachmawati et al, 2024). In addition, physics learning is still dominated by conventional teacher-centered instruction, where teachers act as the main source of information and students tend to be passive learners (Melawati et al, 2022). The worksheets commonly used in schools also mostly contain collections of questions without clear step-by-step guidance for solving problems (Nenggala et al, 2024). As a result, students often experience difficulties in developing systematic thinking when solving complex physics problems. This condition is further strengthened by the limited integration of digital technology in learning materials, reducing opportunities for interactive and contextual learning experiences (Asrizal, A., & Festiyed, 2020). Therefore, innovative digital learning materials are needed to support students in developing structured problem-solving skills and improving engagement in physics learning.

Electronic Student Worksheets are a form of digital instructional innovation aimed at facilitating active, engaging, and self-directed learning. In contrast to traditional printed worksheets, e-students worksheet incorporates multimedia elements such as videos, animations, simulations, and hyperlinks, which enhance the overall learning experience (Prahani et al, 2022). In addition, e-students worksheet provides high accessibility, allowing students to access learning materials anytime and anywhere digital devices like smartphones, tablets, and computers, thus promoting flexible and time-independent learning (Linggar Jati et al., 2024). A meta-analysis by Muslimin, M., & Purwaningsih, (2023) revealed that worksheets designed using a Problem-Based Learning (PBL) approach significantly improve students' problem-solving skills in physics, with a strong effect size. Hadira (2024) reported that PBL-based e-modules effectively enhance both problem-solving skills and students' self-efficacy. These results highlight the significant potential of integrating digital learning materials with problem-based approaches to support comprehensive student development. Consequently, developing a problem-solving-oriented e-students worksheet for motion dynamics is both highly relevant and necessary.

The problem-solving approach in physics education is an instructional strategy that uses real-world problems as the foundation of learning activities, encouraging students to systematically identify, examine, and resolve physics-related issues. This approach is grounded in constructivist learning theory, which emphasizes that learners actively construct knowledge through meaningful cognitive engagement (Usmeldi & Amini, 2022). Polya's framework outlines four essential stages of problem-solving: comprehending the problem, planning a solution, executing the plan, and evaluating the results (Rachmawati et al, 2024). Incorporating these stages into the design of e-students worksheet provides important cognitive scaffolding that supports students in managing their thinking processes when dealing with complex physics tasks. A study by Novita et al (2024) revealed that problem-solving-based e-students worksheet developed using the Liveworksheet platform significantly enhances students' critical thinking skills, as its structured guidance helps them organize and regulate their reasoning processes. Thus, integrating a problem-solving approach into e-students worksheet offers a clear cognitive framework while fostering learner independence.

Research on students' challenges in physics problem-solving indicates that a major difficulty lies in their inability to connect conceptual understanding with mathematical representation in an integrated manner. Mufida et al, (2021) reported that high school students encounter considerable difficulties in solving physics problems in online learning settings, particularly in designing solution strategies and evaluating their answers. Anggrainiet al, (2022) found that vocational high school students demonstrate low problem-solving performance in direct current electricity topics, with the weakest aspect being the evaluation stage. These findings highlight the need for physics instruction to be designed more explicitly to guide students through each phase of problem-solving, rather than relying solely on sets of practice questions without clear procedural support. Learning materials that provide structured, step-by-step guidance have been shown to be more effective in enhancing students' competencies compared to traditional worksheets that merely present questions (Diana, R., & Makiyah, 2021). Therefore, the development of problem-solving-based e-students worksheet for motion dynamics should explicitly include structured, contextual, and adaptive problem-solving stages. This is intended to ensure that students not only obtain correct answers but also develop a deep understanding of the scientific reasoning processes involved.

Needs analysis is an important initial stage in developing instructional materials because it provides the basis for determining the design, content, and direction of the product. Without a thorough analysis, the developed materials may not align with students' needs, characteristics, or classroom conditions (Pasaribu et al, 2022). In developing a problem-solving-based e-students worksheet for motion dynamics, the analysis includes identifying students' learning difficulties, examining prior knowledge, reviewing existing teaching materials, and understanding teachers' instructional needs. According to Asrizal, A., & Festiyed, (2020) stated that instructional materials developed through comprehensive needs analysis are generally more relevant and effective in improving students' competencies. Similarly, Astuti (2024) found that systematic needs analysis can reveal learning gaps that are not accommodated by conventional materials. Therefore, this study conducts a detailed needs analysis as the foundation for developing a problem-solving-based e-students worksheet in motion dynamics.

Furthermore, the integration of digital technology in physics learning has become an important necessity, especially for Generation Z students who are closely connected to digital environments. Li et al. (2021) found that teacher support in project-based learning significantly improves students' scientific modeling and problem-solving abilities. Similarly, Sukaesih et al. (2022) reported that the combination of project-based learning and mind mapping enhances students' conceptual understanding and analytical problem-solving skills. In Indonesia, Usmeldi et all (2022) also showed that creative project-based learning can improve students' creativity and innovation. These findings indicate that the development of a problem-solving-based e-students worksheet for motion dynamics has strong potential to improve students' problem-solving skills. By integrating structured problem solving activities with digital platforms, the e-students worksheet is expected to create more interactive, meaningful, and contextual learning experiences.

From the discussion above, it can be concluded that there is a mismatch between the need for problem-solving-oriented physics learning and the limited availability of structured digital instructional materials. Existing learning materials are still dominated by conventional resources that do not effectively guide students through systematic problem-solving processes in motion dynamics. In addition, both students and teachers expressed a strong need for interactive and contextual digital learning media to support active learning. Therefore, this study aims to analyze the needs and contextual factors underlying the development of a problem-solving-based e-students worksheet for motion dynamics. This research employed a qualitative descriptive approach using observations, interviews, and questionnaires involving teachers and students. The findings are expected to contribute to the development of innovative and competency-based digital physics learning materials for senior high schools.

METHODS

This study employed a Research and Development (R&D) method using the Plomp development model. The model consists of three main stages, namely preliminary investigation, prototyping, and assessment. However, this research was limited to the prototyping stage due to time and resource constraints. The study focused on analyzing the needs and practicality of the developed problem-solving-based e-students worksheet for Dynamics of Motion. The research was conducted at SMA Baiturrahmah Padang from July to December 2025.

The participants in this study consisted of physics lecturers from Universitas Negeri Padang, physics teachers, and tenth-grade students of SMA Baiturrahmah Padang. The lecturers acted as experts as validator to assess the validity of the developed e-students worksheet. Meanwhile, teachers and students participated in the practicality testing process. The participants were selected using purposive sampling based on their relevance to the objectives of the study. This sampling technique was chosen to ensure that the participants could provide appropriate information related to the product development process.

The research procedure began with the preliminary investigation stage, which included educational context analysis, student characteristic analysis, and literature review. The educational context analysis was conducted through interviews with physics teachers to identify instructional problems and limitations of existing teaching materials. Student characteristic analysis aimed to identify students' learning needs, prior knowledge, and problem-solving abilities. Afterward, the prototyping stage was carried out through designing the e-students worksheet and conducting formative evaluations. The formative evaluations included self-evaluation, expert review, one-to-one evaluation, and small-group evaluation to examine the validity and practicality of the developed product.

The instruments used in this study included interview guidelines, observation sheets, questionnaires, and validation and practicality assessment sheets. Interview guidelines were used to collect information regarding instructional problems and the use of teaching materials in physics learning. Questionnaires were administered to students and teachers to identify learning needs and responses toward the developed e-students worksheet. The validation sheets were used by experts as validator to evaluate the feasibility of the product in terms of content, language, presentation, and design. In addition, practicality sheets were used to assess the ease of use, attractiveness, efficiency, and usefulness of the developed e-students worksheet.

The collected data were analyzed descriptively to determine the feasibility and practicality of the developed e-students worksheet. The needs analysis data were obtained using a five-point Likert scale questionnaire ranging from strongly disagree to strongly agree and were converted into percentages. The validity data were analyzed using Aiken's V index to determine the level of agreement among experts regarding the product feasibility. The resulting validity scores were categorized into valid and not valid criteria based on predetermined interpretation standards. Meanwhile, the practicality data obtained from teachers and students were analyzed using percentage scores and categorized into very practical, practical, fairly practical, less practical, and not practical levels.

RESULTS AND DISCUSSION

Results

Students Problem Solving Skills Problems

The stage of analyzing educational problems is the initial step in the development of e-students worksheet on Motion Dynamics based on problem solving. This analysis is conducted through a preliminary study that includes classroom observation, interviews with physics teachers, and giving questionnaires to students. The analysis results identify three main problems that form the basis for product development. Can be seen in table 1.

Table 1.Profile of Students' Problem-Solving Ability

No.	Problem-Solving Indicator	Description	Percentage Mastery (%)
1	Problem Identification	Students' ability to understand and define the given physics problem	13%
2	Planning Solution Strategy	Ability to select relevant concepts, principles, and physics equations to solve problems	29.7%
3	Implementing the Solution Plan	Ability to apply the solution strategy systematically and in a structured manner	44%
4	Evaluation and Reflection	Ability to recheck answers and reflect on the problem-solving process	36.17%
		Average	30.71%

Data in Table 1 show that students' average problem-solving ability only reached 30.71%, which is categorized as low. The lowest percentage was found in the problem identification indicator (13%), indicating that many students still have difficulties understanding and defining physics problems correctly. The planning solution strategy indicator also showed a low result (29.7%), suggesting that students are not yet able to systematically select appropriate concepts and equations when solving problems. Although the implementation of the solution plan reached a relatively higher percentage (44%), students still faced challenges in applying problem-solving procedures in a structured manner. In addition, the evaluation and reflection indicator remained low (36.17%), indicating that students rarely recheck or reflect on their solutions. These findings suggest that students still need instructional materials that explicitly guide each stage of problem solving and support systematic thinking skills.

Problem in Teaching Materials

Interview results with a physics teacher at SMA Baiturrahmah, which became the location of the research, reveal that the available teaching materials are still dominated by conventional textbooks and printed student worksheets that are procedural. The available teaching materials have not explicitly included the systematic steps of problem solving, so students tend to memorize the procedures for solving without understanding the underlying concepts. The problems related to teaching materials can be seen in Table 2.

Table 2. Problem Teaching Materials

No.	Aspect Assessed	Current Condition	Percentage Inadequacy (%)
1	Availability of digital or electronic based teaching materials	Very limited, only in the form of photocopies of the package book	78.5
2	Integration of problem-solving steps in e-students worksheet	E-students worksheet is not yet available with explicit problem-solving steps	91.2
3	Engagement of real context in teaching materials	Practice questions are artificial, not contextual	83.4
4	Support of teaching materials toward higher-order thinking	Dominance of memory and understanding questions (C1–C2)	86.7
5	Interactivity of teaching materials	Teaching materials are passive, one-way	94.3

Data in Table 2 indicate a very strong need for electronic teaching materials that are interactive and oriented toward problem-solving. The highest percentage of inadequacy appears in the interactivity aspect (94.3%), showing that the existing materials are still one-directional and less engaging for students. Furthermore, the integration of problem-solving stages reached 91.2%, indicating that current worksheets do not yet provide clear and systematic guidance in solving physics problems. The findings also show that the available materials still focus more on memorization and routine exercises than on developing higher-order thinking skills. Consequently, students have limited opportunities to practice analytical and structured thinking during the learning process. Therefore, the development of problem-solving-based e-students worksheets equipped with explicit scaffolding is considered highly necessary.

To identify students' learning needs, a questionnaire was distributed to eleventh-grade students from the selected research schools. The questionnaire aimed to explore students' perceptions of physics learning, problem-solving difficulties, and the need for interactive digital teaching materials. The collected data provide important information regarding students' expectations for learning resources that can support more effective and meaningful physics learning. The results of the student needs analysis presented in Table 3.

Table 3. Recapitulation of Student Needs Survey Results (n = 68)

No.	Statement	Agree / Very Agree (%)	Doubtful (%)	Not Agree (%)
1	I need teaching materials that guide step-by-step steps in solving physics problems	88.2	8.8	2.9
2	I find it easier to learn physics when presented through interactive digital/electronic media	85.3	11.8	2.9
3	I have difficulty understanding Motion Dynamics material because I do not know how to systematically solve problems	79.4	14.7	5.9
4	I need example problems in real-life contexts to help understand physics concepts	91.2	5.9	2.9
5	I require direct feedback when working on physics practice problems	94.1	4.4	1.5
6	I feel motivated if teaching materials present problem challenges with varying levels of difficulty	82.4	11.8	5.9

The survey results presented in Table 3 indicate that students have a strong need for interactive teaching materials that support problem-solving activities. Most students agreed that learning materials should provide direct feedback to help them understand mistakes and improve their understanding during the learning process. The highest percentage was found in the need for immediate feedback (94.1%), followed by the need for real-world contextual problems in teaching materials (91.2%). In addition, students also expressed the importance of learning resources that can guide them systematically in solving physics problems. These findings show that conventional teaching materials are no longer sufficient to meet students' learning needs in physics. Therefore, the development of a PBLL-based e-students worksheet equipped with interactive features, structured scaffolding, and formative feedback is considered highly necessary.

Problem in Learning Materials

The analysis of learning objectives was conducted by reviewing the Learning Achievements, Learning Objective Flow, and High School Physics Teaching Modules based on the Independent Curriculum. This analysis was intended to ensure that the developed e-students worksheet is aligned with the competencies targeted in the curriculum. In addition, the analysis also aimed to identify problem-solving indicators that can be integrated into each learning activity systematically. The formulation of the learning objectives in Table 4.

Table 4. Analysis of Students' Difficulties on the Subtopic of Kinematics Dynamics

No.	Subtopic	Type of Difficulty	% Students Experiencing Difficulty	Category
1	Newton's First Law (Inertia)	Conceptual: misunderstanding of force equilibrium conditions	68..4	Highest
2	Newton's Second Law (F = ma)	Procedural: errors in drawing free-body diagrams (FBD)	74.2	High

3	Newton's Third Law (Action-Reaction)	Conceptual: incorrect identification of action-reaction force pairs	61.8	High

The data presented in Table 4 indicate that the Motion subtopic, especially Newton's Second Law, exhibits the highest difficulty level at 74.2%, followed by Newton's First Law at 68.4%. These findings suggest that students experience more challenges in understanding and applying concepts related to Newton's laws of motion. The identified difficulties are both conceptual and procedural in nature, indicating that students struggle not only with the ideas but also with the steps required to solve problems. This condition shows the need for a more structured learning approach. Such an approach should be able to systematically guide students through each stage of problem-solving. By doing so, students are expected to better understand and apply the concepts effectively.

Analysis of Learning Setting

Analysis of learning setting covers aspects of context, environment, and real conditions that will serve as a reference in designing the e-students worksheet. This analysis focuses on examining the technology infrastructure conditions that support the implementation of the e-students worksheet in the learning process. Understanding these conditions is important to ensure that the developed product can be accessed and utilized effectively by students and teachers. The results of the analysis are presented in Table 5.

Table 5. Technology Infrastructure Condition in the Schools of the Research Location

No.	Aspect Infrastructure	Condition in School A	Condition in School B	Condition in School C
1	Availability smartphone devices owned by students	95.3% students have smartphones	92.7% students have smartphones	88.4% students have smartphones
2	Availability computers/ laptops in laboratory	32 units (ratio 1:1.2)	28 units (ratio 1:1.4)	24 units (ratio 1:1.6)
3	Quality internet at school	Good (Wi-Fi available in the lab, speed 50 Mbps)	Fair (Wi-Fi in some areas, speed 20 Mbps)	Limited (Wi-Fi only in teacher lounge, speed 10 Mbps)
4	Usage LMS/digital platform in learning	Google Classroom actively used	Google Classroom sometimes used	Not yet active LMS
5	Teacher digital literacy physics	High: actively developing digital media	Medium: using existing media	Enough: requires assistance

The infrastructure data in Table 5 indicate that smartphone ownership among students is relatively high, with an average percentage of 92.1%. However, the quality and stability of internet access in schools show variation across the research sites. This condition suggests that not all students have equal access to reliable online learning environments. Based on these findings, the development of the e-students worksheet is designed using a hybrid approach. The worksheet can be accessed both online and offline to accommodate different connectivity conditions. In addition, it is optimized for smartphone use to ensure accessibility and equitable implementation across the three schools involved in the study.

Analysis of 21st Century Skills

The table presents the distribution of students' 21st century skills based on four key competencies. These competencies include critical thinking, creative thinking, communication skills, and collaboration skills. Each skill is expressed in percentage form to illustrate the level of mastery among students. The data provides an overview of which skills are most and least developed in the observed group in table 6.

Table 6. Indicators of the Century Skills Twenty First

No.	Twenty First Century Skills	Percentage	Category
1	Critical Thinking	23.61%	Low
2	Creative Thinking	71.78%	High
3	Comunication Skills	76.37%	High
4	Colaboration Skills	77%	High

Based on the table 6, collaboration skills show the highest percentage at 77%, followed closely by communication skills at 76.37%. This indicates that students are relatively strong in working together and exchanging ideas effectively in group settings. Creative thinking also appears to be well-developed with a percentage of 71.78%, suggesting that students are fairly capable of generating new ideas and approaches. However, critical thinking is significantly lower at 23.61%, showing that students still face challenges in analyzing, evaluating, and solving problems deeply. This gap suggests that learning activities may not yet fully support higher-order thinking skills. Therefore, instructional strategies need to be improved to better foster critical thinking while maintaining the development of other 21st century skills.

Discussion

The findings of this study indicate that students' problem-solving skills in motion dynamics remain low, particularly in problem identification and solution planning. According to Polya's problem-solving theory, understanding the problem and planning a solution are fundamental stages that determine the effectiveness of subsequent problem-solving processes. The low achievement in these indicators suggests that students have not yet developed systematic thinking skills required to solve physics problems effectively. This finding is consistent with the study conducted by Mufida et al. (2021), which reported that high school students experienced difficulties in designing solution strategies and evaluating answers in physics learning. Similarly, Silvianti et al. (2022) found that students often struggle to connect physics concepts comprehensively when solving complex motion-related problems. Therefore, the results of this study reinforce the view that students require structured learning support to guide them through each stage of problem-solving.

The study also revealed a strong need for interactive digital teaching materials that integrate explicit problem-solving stages, contextual problems, and immediate feedback. This finding aligns with constructivist learning theory, which emphasizes that knowledge is actively constructed through meaningful learning experiences and cognitive engagement. In this context, electronic student worksheets can function as learning scaffolds that help students organize and regulate their thinking processes. Previous studies support this finding. Muslimin and Purwaningsih (2023) reported that problem-based worksheets significantly improve students' problem-solving abilities in physics, while Novita et al. (2024) found that problem-solving-based electronic worksheets effectively enhance students' critical thinking skills through structured guidance. In addition, Hadira et al. (2024) demonstrated that digital learning materials based on problem-solving approaches improve both students' self-efficacy and learning outcomes. These findings indicate that the development of a problem-solving-based electronic student worksheet for motion dynamics is theoretically and empirically justified to address students' learning needs.

This study has several limitations that should be considered when interpreting the findings. First, the research was limited to the needs analysis stage and did not examine the effectiveness of the developed electronic student worksheet in improving students' problem-solving skills. Second, the participants were drawn from a limited number of schools, which may restrict the generalizability of the findings to broader educational settings. Third, the data were primarily collected through questionnaires, observations, and interviews, which may be influenced by respondents' perceptions and subjective judgments. Therefore, future studies should continue the development process through product validation, implementation, and effectiveness testing involving larger and more diverse samples to provide stronger evidence regarding the impact of the developed electronic student worksheet.

CONCLUSION

The results of the needs analysis indicate a strong necessity for the development of problem-solving-based digital learning materials to support physics learning, particularly in the topic of Dynamics of Motion. Students still demonstrate low problem-solving abilities, especially in identifying problems and planning solution strategies, which reflects limited systematic and metacognitive thinking skills. Existing instructional materials are generally conventional, exercise-oriented, and lack structured guidance that can assist students in solving problems step by step. In addition, the integration of technology, contextual learning, and higher-order thinking skills in current learning resources remains limited. The findings also show that students' 21st-century skills, such as critical thinking, creativity, communication, and collaboration, are not yet fully developed and require more interactive and student-centered learning approaches. Furthermore, students experience difficulties in understanding Newton's Laws, constructing free-body diagrams, and interpreting action-reaction force pairs. Despite these challenges, the learning objectives have been aligned with higher-order cognitive levels and structured according to Polya's problem-solving framework to support systematic cognitive development. Therefore, the development of a problem-solving-based e-students worksheet is considered essential to provide structured, contextual, and meaningful learning experiences that can improve students' problem-solving competence.

REFERENCES

Anggraini, R. D., Prastowo, T., & Sudibyo, E. (2022). Analysis of Problem Solving Skills in the Vocational High School Using Direct Current Electricity as a Case Study. *IJORER: International Journal Of Recent Educational Research*, *3*(3), 301–311.

Asrizal, A., & Festiyed, F. (2020). Studi Pendampingan Pengembangan Bahan Ajar Tematik Terintegrasi Literasi Baru dan Literasi Bencana pada Guru IPA Kabupaten Agam. *Jurnal Eksakta Pendidikan (JEP)*, *8*(4), 97–104.

Astuti, L. D. (2024). Needs Analysis of Electronic Module Based on PBL to Improve Students Collaboration Skills. *Kasuari: Physics Education Journal (KPEJ) Universitas Papua*, *7*(2), 409–416.

Diana, R., & Makiyah, Y. S. (2021). The Effectiveness of Student Worksheets (LKPD) Based on the Problem Based Learning (PBL) Model to Improve Problem-Solving Skills in Multiple Gap Interference Material. *Jurnal Pendidikan Fisika*, *10*(1), 48–54.

Hadira, H., Sari, M. S., & Sulisetijono, S. (2024). Development of E-Modules Based on Problem-Based Learning to Improve Problem-Solving Skills and Student Self-Efficacy. *Jurnal Penelitian dan Pengkajian Ilmu Pendidikan: E-Saintika*, *8*(1), 86–101.

Li, T., Miller, E., Chen, I. C., Bartz, K., Codere, S., & Krajcik, J. (2021). The Relationship Between Teacher's Support of Literacy Development and Elementary Students' Modelling Proficiency in Project-Based Learning Science Classrooms. *Education 3-13*, *49*(3), 302–316.

Melawati, O., Evendi, E., Halim, A., Yusrizal, Y., & Elisa, E. (2022). Influence of the Use of Student Worksheet Problem-Based to Increase Problem Solving Skills and Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 346–355.

Mufida, S. N., Sinaga, P., & Samsudin, A. (2021). Identification of Physics Problem-Solving Skills on Senior High School Students: An Evaluation of E-Learning During Covid-19 Pandemic in Tuban. *Journal Of Physics: Conference Series*, *1*(2098).

Muslimin, M., & Purwaningsih, E. (2023). M. P. L. Berbasis P. terhadap Kemampuan Berpikir Kritis dan Pemecahan Masalah dalam Fisika. (2023). Meta-Analisis: Pengaruh LKPD Berbasis PBL terhadap Kemampuan Berpikir Kritis dan Pemecahan Masalah dalam Fisika. *Jurnal Pendidikan Matematika Dan Sains*, *11*(2), 38–45.

Nenggala, M. P., Razi, P., Hidayati, H., & Sari, S. Y. (2024). Electronic Student Worksheet for Solving Problems in Physics Material Based on Problem-Based Learning. *International Journal Of Information And Education Technology*, *7*(14), 945–954.

Novita, L., Sirait, J. V., & Mufida, S. N. (2024). Improving Problem-Solving Skills Through the Physics Education Technology Assisted Problem Based Learning Model Electronic Student Worksheets. *Revista Mexicana De Física E*, *2*(21), 1-5.

OECD. (2023). The State Of Learning And Equity In Education. *OECD Publishing*, *1*.

Pasaribu, A., Hartini, S., & M. (2022). Analisis Kebutuhan Pengembangan LKPD Berbasis STEM untuk Melatih Berpikir Kritis Materi Elastisitas dan Hukum Hooke. *Jurnal Ilmiah Pendidikan Fisika*, *6*(3), 682–693.

Prahani, B. K., Rizki, I. A., Nisa, K., Citra, N. F., Alhusni, H. C., & W. (2022). Implementation of Online Problem-Based Learning Assisted by Digital Book with 3D Animations to Improve Students' Physics Problem-Solving Skills in Magnetic Field Subject. *Jurnal Penelitian Pendidikan IPA*, *6*(8), 2846–2855.

Rachmawati, O. Q., Purwaningsih, E., & Parno, P. (2024). Improvement of Students' Problem-Solving Skill on Physics Learning: A Meta-Analysis. *Berkala Ilmiah Pendidikan Fisika*, *2*(12), 232–244.

Saleh, S. (2015). Sistem Propulsi Elektrik. *Slide Share*, *12*(1), 1–29.

Silvianti, N., Chusni, M., & Ibrohim, A. (2022). Analisis Keterampilan Pemecahan Masalah Peserta Didik pada Materi Gerak Parabola di SMAN 2 Majalengka. *Jurnal Inovasi Penelitian Pendidikan dan Pembelajaran*, *1*(2), 1–10.

Sukaesih, S., Zubaidah, S., Mahanal, S., & Listyorini, D. (2022). Enhancing Students' Nature of Science Understanding Through Project-Based Learning and Mind Mapping. *International Journal of Evaluation and Research in Education*, *4*(11), 1704–1713.

Sukaesih, S., Zubaidah, S., Mahanal, S., & Listyorini, D. (2022). *Enhancing Students ' Nature of Science Understanding Through Project-Based Learning and Mind Mapping*. *11*(4), 1704–1713.

Usmeldi, U., & Amini, R. (2022). Creative Project-Based Learning Model to Increase Creativity of Vocational High School Students. *International Journal of Evaluation and Research in Education*, *11*(4), 2155–2164.

Usmeldi, U., & Amini, R. (2022). *Creative Project-Based Learning Model to Increase Creativity of Vocational High School Students*. *11*(4), 2155–2164.

Wardhani, U. K., & Setyarsih, W. (2021). Kajian Literatur Pengembangan Instrumen Kemampuan Problem Solving pada Materi Fisika. *IPF: Inovasi Pendidikan Fisika*, *2*(10), 16–27.