Journal of Innovative Physics Teaching
Volume 3, Issue 1 June 2025, 106 – 119
ISSN: 3021-8551 (Online)
Doi: https://doi.org/10.24036/jipt/vol3-iss1/86
https://jipt.ppj.unp.ac.id/index.php/jipt

Need Analysis to Develop Electronic Student Worksheet Based on Problem Based Learning to Improve Students' Problem-Solving Skills

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Article Info

Article history:

Received month dd, yyyy
Revised month dd, yyyy
Accepted month dd, yyyy

Keywords:

E-SWS
Problem Based Learning
Renewable Energy
Problem Solving Skill

ABSTRACT

Twenty first century learning demands that students possess critical thinking, creativity, and problem-solving skills. However, physics education in Indonesia particularly in the topic of renewable energy is still conducted using conventional methods and lacks active student involvement. In fact, this topic has the potential to foster higher-order thinking skills. This study aims to analyze the need for the development of a Problem-Based Learning (PBL) based Electronic Student Worksheet (E-SWS) to improve students' problem-solving abilities. A needs analysis was conducted to gain a comprehensive understanding of the learning conditions, challenges encountered, and appropriate teaching material specifications. The method used was descriptive with a mixed quantitative and qualitative approach, utilizing questionnaires and interviews. The research findings indicate that: (1) students feel bored and unmotivated when learning physics; (2) the learning models and media used are not optimal in enhancing understanding and thinking skills; (3) the teaching materials, particularly the student worksheets, are not yet technology-based and the content is inadequate; and (4) students' problem-solving abilities are still low, reaching only 38.9%. These findings highlight the need to develop a PBL-based E-SWS as a solution to enhance students' learning interest and problem-solving skills in the digital era.

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INTRODUCTION

Education in the era of globalization must innovate to create 21st century learning that is adaptive, interactive, and oriented towards competency development. In this context, learning no longer focuses on the ability to memorize, as is still often the case in Indonesia, but rather emphasizes the development of critical thinking skills, creativity, and problem-solving skills relevant to everyday life (Anwar, 2022). In addition, the learning process

should encourage the achievement of new knowledge, skills, experiences, and attitudes that enable learners to learn and change their behavior constructively (Asrizal et al., 2019). Thus, the 21st-century learning is capable of shaping human resources that have comprehensive competencies to face various challenges and opportunities in the 21st century.

One of the main challenges in education today is how to equip learners with higher-order thinking skills, one of which is problem-solving skills. Problem-solving skills are the ability to identify issues, propose various solutions, and determine the appropriate solution choice based on the data obtained (Safitri et al., 2023). This ability is very important in real life because students are not only required to master concepts but also to be able to apply them in complex and dynamic situations. This is because problem-solving skills will encourage students to think in order to solve problems using applicable principles and laws (Sanjaya et al., 2024). The importance of having problem-solving abilities among students will enhance their experience in finding solutions to existing problems.

In the context of science learning, especially on the subject of renewable energy, a strong conceptual understanding and skills in analyzing and evaluating various problems occurring in the surrounding environment are necessary. The topic of renewable energy is one of the subjects in physics at the high school level. The scope of this material includes the basic concepts of energy, renewable energy, the urgency of meeting energy needs, as well as the potential of renewable energy in Indonesia (Karira et al., 2023). This material is highly relevant to current global issues, such as the energy crisis and climate change, making it very potential to support the development of problem-solving skills in students. However, based on initial observations and literature studies, learning on this topic is still conducted conventionally, with minimal student involvement and has not been effective in encouraging the improvement of problem-solving skills. Previous research also shows that renewable energy material is generally presented in the form of theory and memorization through textbooks that tend to be difficult to understand, less engaging, and boring. In classroom practice, teachers still predominantly use lecture and question and answer methods in delivering the material (Ewar et al., 2023).

The Student Worksheet (SWS) is one of the alternative teaching materials that can be utilized to support the implementation of learning, particularly on the topic of renewable energy. Student worksheet plays a strategic role as a learning medium that is designed to optimize the learning process to achieve the established instructional goals (Pawestri & Zulfiati, 2020). The existence of SWS provides a significant contribution in enhancing the active participation of students, as well as facilitating educators in guiding students to construct understanding through independent learning activities (Chandrawita & Lufri, 2023). In the development process of student worksheets, it is important to pay attention to the characteristics and needs of students in order to support the improvement of problem-solving skills and the utilization of current technology. Along with the progression of time, digital student worksheet or Electronic Student Worksheet (E-SWS) emerges as an innovative form of teaching material that integrates information and communication technology in accordance with the demands of 21st-century learning.

One of the challenges often encountered in the field is the use of student worksheet that remains conventional and tends to focus on routine exercise questions, rather than on developing students' analytical and creative thinking. Student worksheet that only contains mechanistic steps without providing space for exploration and reflection makes the learning process less challenging and limits students' potential to solve real problems. This is consistent with the results obtained by other studies that the teaching materials used are printed books and learning is still conducted conventionally, thus it is considered necessary to develop student worksheet that can train problem-solving skills (Machrevi et al., 2022). Therefore, there needs to be innovation in the development of student worksheet that is not

only content-based but also process-oriented towards students' thinking in solving problems.

In line with these challenges, the Problem Based Learning (PBL) approach emerges as one of the learning models that can encourage students to actively seek information, understand problems, formulate solutions, and reflect on their learning outcomes. The PBL model is a learning model that requires students' mental activity to understand a learning concept through the situations and problems presented at the beginning of the learning process, with the aim of training students to solve problems using a problem-solving approach (Firmansyah et al., 2022). Various studies have shown that the PBL model is a learning strategy that uses real problems for students, making it suitable for enhancing problem-solving skills, motivation, and curiosity (Melawati et al., 2022; Gita et al., 2022). If this approach is integrated in the form of E-SWS, then the learning process not only becomes more meaningful and collaborative but also more in line with the characteristics of the current digital generation that is familiar with technology.

The use of PBL based E-SWS provides flexibility in material presentation, enriches learning resources, and allows for broader interaction both synchronously and asynchronously. However, the development of such devices cannot be done carelessly. A comprehensive needs analysis is needed as a basis for understanding the real conditions in the field. As stated by Sandong et al. (2023), an in-depth understanding of instructional needs is essential to design learning objectives that are effective and relevant to the learning context. In analyzing students' needs, researchers must consider many things, such as students' learning styles, students' level of understanding of the material, and students' ability and readiness to use technology (Anisa et al., 2024). Therefore, needs analysis is a crucial first step in ensuring that the E-SWS developed is truly able to answer the challenges and support the learning process optimally.

Before establishing the development of E-SWS, a comprehensive analysis of the conditions on the ground is needed to deeply identify various emerging problems, including causes, constraints, and limitations of the teaching materials and learning media that have been used in schools. Therefore, conducting a needs analysis becomes a very strategic initial stage to ensure that the products to be developed are truly aligned with the needs and expectations of users. The aim of this analysis research is to identify teaching materials that can be optimally designed for the subject of physics, particularly in the topic of renewable energy, to meet the needs of students (Amelia et al., 2024). Through the results of this research, it is hoped to obtain an initial picture of the types of learning materials that need to be developed in physics teaching, especially on renewable energy materials.

In previous research conducted by Vitrianingsih et al. (2021) the analysis of needs in the development of student worksheets based on problem-based learning was discussed, but it was focused on the material of elasticity and Hooke's law, rather than on the topic of renewable energy. Meanwhile, the research by Sakti & Emiliannur (2024) examines the needs analysis for the development of electronic student worksheet on renewable energy material, but uses an ecopreneurship approach to foster students' environmental awareness.

Based on this description, this research is focused on analyzing the needs of developing E-SWS based on problem based learning on renewable energy material. This research aims to identify various problems in the physics learning process, which then become the basis for developing teaching materials in the form of E-SWS based on PBL on the topic of renewable energy, in order to improve students' problem solving skills. This research is expected to make a real contribution in the design of learning tools that are innovative, contextual, and support the achievement of Pancasila learner profiles that are able to think critically, creatively, and care about environmental issues.

METHODS

The research method applied in this study is descriptive research, which combines quantitative and qualitative approaches. Descriptive research is a type of research aimed at describing a phenomenon, event, or occurrence that is currently taking place. The focus of this study is on actual problems in accordance with the real conditions at the time the research is conducted (Witara et al., 2023). This research combined quantitative and qualitative approaches to explore the subject more comprehensively (Novisya & Desnita, 2020). The use of these two approaches is expected to provide a more comprehensive and in-depth understanding of the phenomenon being studied.

The needs analysis in this research aims to identify the problems in learning to obtain a solid foundation for developing teaching materials in the form of electronic student worksheet based on problem-based learning. The needs analysis was conducted in three schools located in Tebo Regency, namely SMA N 7 Tebo, SMA N 11 Tebo, and SMA N 20 Tebo. There are two objects studied in this needs analysis. The research objects are 3 physics teachers and 78 Phase E students of Class X. From the physics teachers as research objects, information was obtained regarding the learning process conducted by the teachers, the teaching materials previously used by the teachers, the use of learning media, and the use of learning models. Meanwhile, from the Phase E Class X students, information was obtained regarding the characteristics of the students and to see the level of problem-solving skills of the students.

The stages of the research consist of four phases. First, preparation stage, the researcher plans the research by developing interview instruments and student questionnaires. Implementation stage, the researcher collects data by conducting interviews with teachers, distributing questionnaires to students, administering a problem-solving ability test, and conducting document studies to identify the need for instructional material development and the readiness to use such materials. Research findings, the researcher analyzes the findings and draws conclusions. Reporting stage, the researcher prepares a report based on the research results (Rakhman et al., 2023).

The instruments used in data collection for quantitative data are student questionnaires. The questionnaire distributed to students is a student characteristics questionnaire. In addition, the test conducted is a problem-solving ability test for students. The purpose of this test is to determine the level of students' problem-solving abilities. As for qualitative data, the instrument used is interviews with the physics teacher. The type of interview used by this researcher is an open-ended interview or more commonly known as unstructured interview.

The technical analysis for qualitative data is carried out by reducing data, presenting and verifying data, while the analysis of quantitative data is done by processing and categorizing the obtained data. The analysis technique for the problem-solving ability test results is descriptive statistics. Descriptive statistics is a type of statistics used to describe or explain the characteristics of the objects being studied based on data obtained from samples or populations, according to actual conditions. In descriptive statistics, no further analysis or generalization conclusions are made. The average results of the problem-solving ability tests of the students are then interpreted based on the categories of the students' problem-solving abilities.

Table 1. Categories of Students' Problem-Solving Abilities

Students' Scores	Assessment Category
81 – 100	Very Good
61 – 80	Good
41 – 60	Average
21 – 40	Deficient

0 – 20	Unsatisfactory

(Ariani et al., 2017)

RESULTS AND DISCUSSION

RESULTS

This research was conducted as an initial study to reveal the developed Electronic Student Worksheet. The preliminary study was carried out by analyzing the needs in learning physics related to student characteristics, teaching materials, learning models, learning media, material analysis, and the results of students' problem-solving ability tests. The first research results were obtained from teacher interview questionnaires. The results of the interviews with teachers used short questions with direct interview methods. Answers from the interviews regarding the learning process and teaching materials used by teachers can be seen in Table 2.

Table 2. Results of the Teacher Interviews

No	Question	Answer
1.	What curriculum are you currently using?	100% of teachers have stated that they are using the Kurikulum Merdeka
2.	What learning models do you use in the learning process with the Kurikulum Merdeka?	25% of teachers respond using the Problem Based Learning model, 75% of teachers respond using the Direct Instruction model
3.	What teaching materials do you use when teaching in the classroom?	Printed teaching materials are package books from school and teaching materials sourced from the internet, such as modules and worksheets
4.	What teaching media do you often use in your teaching?	25% of the learning media used are PPT and videos, while 75% do not use learning media
5.	In your opinion, do the current physics textbooks used engage students' interest and enhance their problem-solving abilities?	- It has not been able to attract students' interest because the teaching materials used are monotonous and incomplete. - The school package books also have not been able to facilitate problem-solving skills.
6.	According to you, are the facilities and infrastructure available at the school adequate for the teaching and learning process of Physics?	The facilities and infrastructure available are adequate for the learning process
7.	Are students allowed to use mobile phones during the learning process?	Students are allowed to bring smartphones to school, but for learning activities, they are only allowed for certain materials
8.	To your knowledge, how is the students' ability after using the teaching materials that were used?	The students' abilities after using the teaching materials, namely the textbooks, do not show significant

		results
9.	Has the use of digital teaching materials ever been applied in the learning process before?	50% of teachers have used digital teaching materials such as videos and digital modules
10.	According to you, what kind of teaching materials can attract students' interest in learning?	- Not only containing writings, but also includes illustrations/images and videos - Learning materials that are colorful so they don't seem boring - Contains comprehensive material

The interview data presented in Table 2 are supported by the results of observations during the learning process in the classroom. The three schools that are the subject of observation have implemented Independent Curriculum. This curriculum emphasizes a fully student-centered learning approach, in line with the concept of freedom to learn. However, in reality, the learning process in the classroom is still dominated by the teacher's role. Based on the results of interviews, it is known that most teachers still tend to use the Direct Instruction model, which emphasizes the dominant role of the teacher and one-way communication in the learning process. Therefore, a fundamental change is needed by adopting the problem based learning model.

To support the application of problem based learning models, appropriate media and teaching materials are needed. In SMA N 7 Tebo, SMA N 11 Tebo, and SMA N 20 Tebo, physics teachers still rely on printed books provided by the school as the main source of learning. Occasionally they use teaching materials from the internet such as modules and student worksheet, but the student worksheet is less interesting because it only contains questions without supporting explanations. In addition, the use of learning media by teachers is still limited. The media that have been used, such as videos and PowerPoint presentations are only about 25% used in the learning process. Teachers only utilize the blackboard and books as media that help learning activities.

According to the opinion of physics teachers who have been interviewed, the teaching materials used are also incomplete and monotonous. In addition, it has not been able to facilitate problem solving skills. This is supported in answer number 8 which states that the ability of students after using teaching materials, namely package books, does not show significant results. In the last question number 10 regarding teaching materials that can attract students' interest in learning, teachers argue that teaching materials do not only contain text, but also have illustrations/pictures and videos. In addition, teaching materials are colorful so that they do not seem boring and most importantly contain complete material.

Further analysis related to questionnaires distributed to students includes interest in learning physics, the use of smartphones at school, and the use of teaching materials at school. Respondents totaled 78 students of class X phase E from SMA N 7 Tebo, SMA N 11 Tebo, and SMA N 20 Tebo. The questions related to interest in learning physics can be seen in Figures 1 and 2 below.

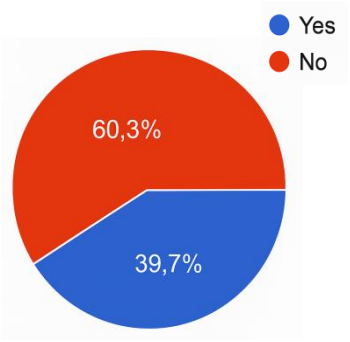

Figure 1. Percentage of Enthusiasm in Learning Physics

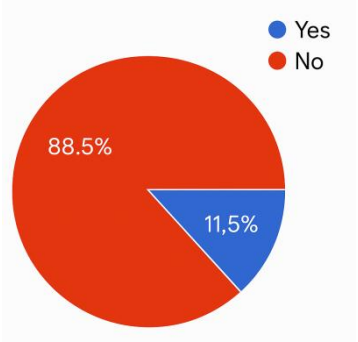

Figure 2. Percentage of Statements Easy to Understand Physics Lessons

The data in Figure 1 shows that 60.3% of students lack enthusiasm when learning physics. As a result, students have difficulty in understanding physics subjects. It can be seen from the data in Figure 2 that 88.5% of students find it difficult to learn physics. This difficulty is caused by the teaching materials used by teachers who only rely on printed books from schools, making it less interesting and unable to actively involve students in learning. This shows the need for innovation in the presentation of teaching materials to make physics learning more interesting and able to increase students' active participation.

In class X phase E, there are three physics topics being studied namely measurement, renewable energy/alternative energy, and global warming. Here, the researcher poses difficult physics questions for class X through a questionnaire to the students.

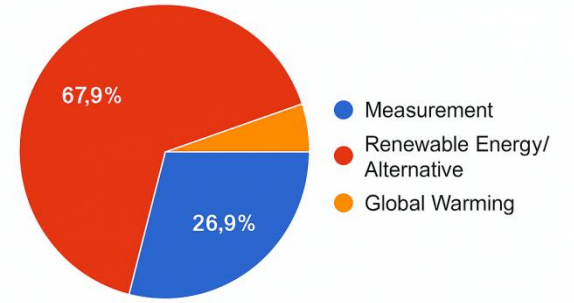

Figure 3. Percentage of Difficult Materials According to Students

The observation results show that there are three physics materials taught in class X phase E, namely measurement, renewable energy, and global warming. From Figure 3, it was found that 67.9% of students chose renewable energy as material that was quite difficult to understand, 26.9% chose measurement material, and the rest chose global warming material. One of the causes of renewable energy being physics material that is difficult for students to understand is the lack of real examples around students and brief explanations on learning resources. The next question aims to find out the role of smartphones on physics learning at school. The results of students' opinions are presented in Figure 4 and Figure 5.

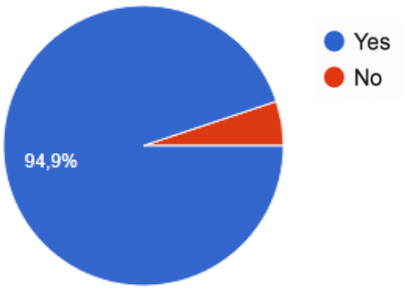

Figure 4. Percentage of Students' Feelings When Using Smartphones for Learning

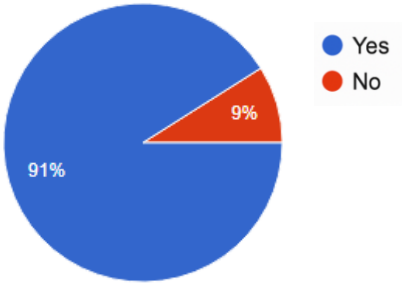

Figure 5. Percentage of Teacher Permission to Use Smartphone in the Learning Process

The data in Figure 4 shows that 94.9% of students enjoy learning using smartphones. Thus, almost all students like to learn physics using smartphones, indicating that students have adapted and utilized technological advancements positively. Furthermore, 91% of students indicated that in school, teachers allow them to use smartphones as a supporting learning tool. The student survey results correspond with the interviews with teachers who stated that students are permitted to bring smartphones to school, and for learning activities, they are only allowed to use them for certain materials.

Furthermore, Figures 6 and 7 present data aimed at determining the teaching materials that are frequently used in studying physics at school, as well as students' preferences for printed or digital student worksheets to support learning activities in the classroom.

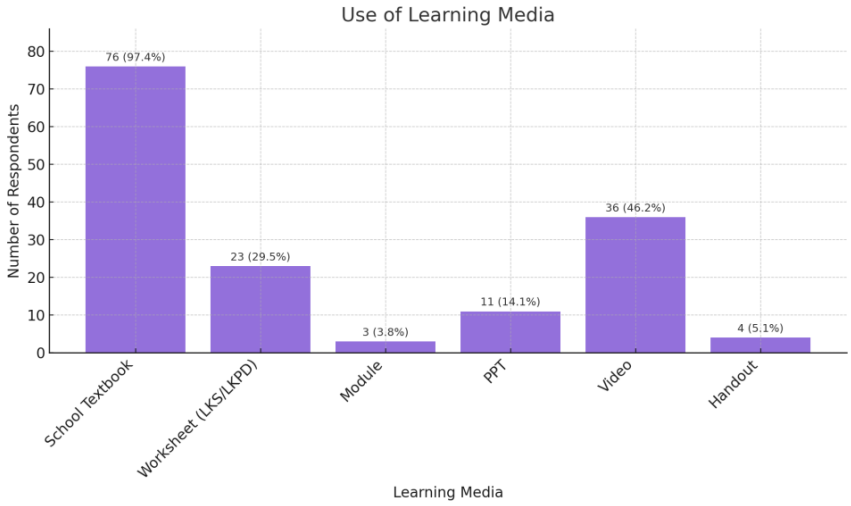

Figure 6. Percentage of Learning Media Used in the Learning Process

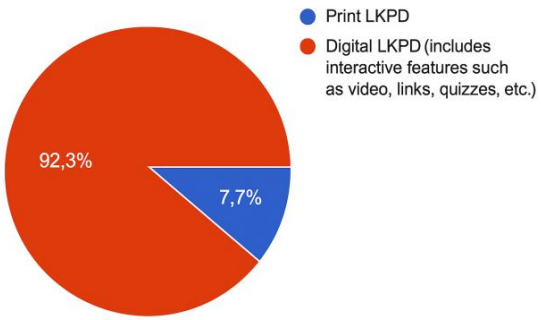

Figure 7. Percentage of Students' Choices Between Printed LKPD or Digital LKPD

Based on the image, it shows that 97.4% of teachers use textbooks/printed materials. This percentage indicates that the teaching and learning activities in schools still rely on printed books as the main source of learning. In addition to using printed books, 46.2% of teachers utilize videos and 29.5% of teachers use worksheets as supplementary learning sources. Other teaching materials include content presented in PowerPoint Presentation (PPT), handouts, and modules. However, the content of the printed books provided by the school is not sufficient to support the learning process of students due to limited material that does not provide real-life context. Furthermore, it cannot support 21st-century skills since it tends to focus on memorization.

Although the level of use of student worksheet by teachers has reached 29.5%, the content of the student worksheet used does not fully reflect the principles of the independent curriculum, which emphasizes the development of 21st century skills. The data in Figure 7 shows students' preferences for the type of student worksheet to be developed. There are two types of student worksheet that are commonly used by teachers, namely student worksheet in printed and digital form. Most learners, 92.3%, prefer digital student worksheets or known as electronic student worksheets. This choice is based on the interactive features offered.

The latest research results are an analysis of students' problem-solving skills. Data were obtained through tests conducted on 78 students in Phase E of grade X. The instrument used to collect data was a problem-solving ability test sheet on renewable energy topics. The analysis of the results obtained from the test of problem-solving ability can be seen in Table 3.

Table 3. Results of the Analysis of Students' Problem-Solving Ability

Statistical Parameter	Scores
number of students	78
Mean	38,9
Modus	35,0
Median	37,5
Minimum	17,5
Maximum	77,5

Based on the data in Table 3, it can be stated that the average score of students' problem-solving ability tests is 38.9. This average score indicates that students' problem-solving abilities are in the insufficient category. The most frequently occurring score and the median score of the problem-solving ability test results are 35.0 and 37.5, respectively. Both scores fall into the insufficient category. The lowest score in the problem-solving ability test is 17.5 while the highest score is 77.5. The number 17.5 is in the very insufficient category, while the number 77.5 indicates that the problem-solving ability test is in the good category. Thus, the results of this data analysis show that students are not yet accustomed to solving given problems.

DISCUSSION

The results of this initial study show that physics learning in high school still faces a number of obstacles, both in terms of learning methods, media use, and the quality of teaching materials. Although the three schools that are the objects of research have implemented the independent curriculum, the practice in the field is still dominated by teacher-centered approaches such as Direct Instruction instead of the Problem Based Learning (PBL) model recommended in the curriculum (Mallu et al., 2024). This finding shows that the implementation of the independent curriculum still faces obstacles,

especially in terms of the availability of infrastructure and teacher readiness in applying the appropriate approach (Naibaho & Suryani, 2023).

The Problem Based Learning (PBL) model is considered relevant to support the implementation of the independent curriculum because it places students as active subjects in learning, encouraging them to develop various 21st century skills. The PBL model is considered capable of developing students' critical thinking and problem solving skills more optimally (Aripin et al., 2021; Cintami et al., 2024; Hafizah & Nurhaliza, 2021). According Astutik & Jauhariyah (2021), PBL is effective in improving students' problem-solving skills, deep conceptual understanding, and metacognitive awareness.

On the other hand, students' low interest in learning physics has become a distinct issue that requires attention. The findings of this study are in line with Raziqin (2020), who stated that the lack of student interest in learning physics is due to the teaching methods and media used by teachers, which are often too monotonous and unengaging (Simaremare et al., 2022). In addition, based on the collected data, students admitted to having difficulty understanding physics subjects and showed a lack of enthusiasm in participating in learning activities. This is consistent with the findings of Sari et al. (2020) which indicated that students often feel bored and unmotivated during physics lessons, ultimately leading to poor understanding of the material.

One of the topics considered difficult by students is renewable energy, which is included in the scope of class X Phase E material. The unreachability of this topic contextually in everyday life and the limited explanation of the material in the textbook are the main causes of students' difficulties in understanding the material (Naufal et al., 2024) This topic is often presented abstractly without concrete examples that are relevant to the students' surrounding environment. As a result, students tend to have difficulty linking the concept of renewable energy with its application in real life.

Interestingly, students have shown enthusiasm for using smartphones as learning aids. Teachers have also begun to create space for students to use these devices in certain learning activities. This indicates that technology-based learning has started to gain acceptance in the school environment. Linda et al. (2023) state that learning materials accessible through Android devices strongly support self-directed and interest-based learning.

However, the learning media used by teachers are still conventional and not interactive. On the other hand, the student worksheets used have also not fully adopted the principles of the independent curriculum. The existing student worksheets structure generally only presents a summary of the material and practice questions without any clear context or guidance (Duri et al., 2024). So that changes are needed by developing teaching materials, especially student worksheets that utilize technology. This is supported by most students showing a preference for Electronic Student Worksheet (E-SWs), which is considered more practical, flexible, and interactive. Sa'diah et al. (2022) explained that E-SWS with multimedia features such as images, animation, audio, and digital links can increase student motivation and participation in learning.

Students' problem solving skills were also found to be low. This shows that the learning they experience has not provided sufficient space for the development of higher order thinking skills. Whereas physics problem solving ability encourages students to connect theoretical concepts with practical applications, thus strengthening their understanding of the material (Djudin, 2023). The lack of problem-solving skills adversely affects students' understanding of concepts and subject matter (Gunada et al., 2023). Therefore, there is a need for structured and innovative learning interventions, especially on challenging materials such as renewable energy.

In response to these conditions, the development of a Problem-Based Learning (PBL) based Electronic Student Worksheet (E-SWS) is a strategic alternative solution. This E-SWS

is not only designed to present content aligned with the demands of the independent curriculum, but also integrates technology to create a more engaging and meaningful learning experience. The development is expected to significantly enhance students' motivation, participation, and problem-solving skills.

The findings of this study reveal that the practice of physics teaching in schools has not yet fully adopted the independent curriculum approach effectively. Teachers tend to rely on conventional teaching methods, using monotonous instructional materials with minimal interactive media. Students exhibit low interest in learning physics, especially in renewable energy topics, which are considered the most challenging. The use of student worksheets is still limited, and their content does not support the development of problem solving skills. Most students expressed a preference for digital learning materials such E-SWS, especially those that are interactive and accessible through electronic devices. On the other hand, test results indicate that students' problem-solving abilities are relatively low, highlighting an urgent need for the development of innovative learning materials that support higher-order thinking skills.

This study has several limitations that should be taken into account. First, the research scope is limited to three schools in the Tebo area, so generalizing the findings to other regions should be done cautiously. Second, the data collected are descriptive in nature and do not yet include effectiveness testing of the developed electronic student worksheet, so its impact on improving students' problem-solving skills remains predictive. Third, data collection methods such as interviews and questionnaires may involve subjective perception biases from both teachers and students. Therefore, further research involving experimental studies and direct product trials is highly recommended to comprehensively test the validity and effectiveness of the electronic student worksheet.

CONCLUSION

Based on the data analysis conducted, there are four findings from the needs analysis in this study. First, students feel bored and lackluster in the physics learning process. Boredom and lack of enthusiasm for learning indicate the need for a more interesting and relevant learning approach for students. Second, the learning model and learning media that have been used have not maximized students in acquiring material and developing students' problem-solving skills. Learning models and media that have not been optimized require innovative learning methods that are able to activate students in understanding the material and practice problem solving skills. Third, teaching materials, especially student worksheet, have not utilized existing technological advances and the content in them is not complete. Conventional teaching materials that are not integrated with technology show the importance of developing complete and interactive digital-based student worksheets. Fourth, the level of problem solving ability of students is still low at 38.9. The low problem-solving ability of students emphasizes the urgency of implementing problem-based learning-based electronic student worksheet to improve higher order thinking skills. Therefore, there is a need for student worksheets that utilize technology, namely the latest electronic student worksheet with a problem-based learning model on renewable energy material to improve students' problem solving skills.

ACKNOWLEDGEMENTS

The researcher would like to thank the head of SMA Negeri 7 Tebo, the head of SMA Negeri 11 Tebo, and the head of SMA Negeri 20 Tebo, who have allowed the research in their schools. The author also thanks Mrs. Reni Marlina, S.Pd, Mr. Delvin Revido, S.Pd, and Mrs. Tri Ratnawati who were willing to be interviewed in this study so that researchers

obtained preliminary data. As well as class X students who have been willing to be respondents in this study, so that researchers obtain initial data as a reference in developing E-SWS based PBL to improve students' problem solving skills. In closing, the author would like to thank all those who have motivated the researcher in the preparation of this article.

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