

Creation of Integrated Problem-Based Learning Electronic Student Worksheets to Improve Problem-Solving Skills Vocational School Students

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ABSTRACT

The rapid advancement of science and technology requires skills such as solving complex problems known as 21st century skills. According to the information collected from this study, the students' problem-solving skills are low. The solution that can be done to improve this problem-solving ability is to create teaching materials in the form of electronic student worksheets integrated with problem-based learning. This study aimed to develop and determine the feasibility and practicality of electronic student worksheets. This research method employs the Dick&Carey model, which consists of nine stages: identifying needs to determine objectives, analyzing learning tasks, Previous research shows that improving problem solving skills can be achieved through the development of problem-based learning-based electronic student worksheets to improve students' problem solving skills. The instrument used was the learners' problem solving ability needs sheet which was filled in by 24 learners. The results of the validation test were obtained with very valid criteria at a value of 0.93. The results of the practicality test were obtained with a fairly practical criterion of a value of 0.74. So it can be concluded that electronic student worksheets integrated problem-based learning to improve the problem-solving ability of vocational school students is valid and practical to use.

Keywords : Electronic Student Worksheets; PBL; Problem Solving.



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I. INTRODUCTION

The rapid advancement of science and technology requires skills such as communication, collaboration, creativity, the ability to solve complex problems, and critical thinking known as 21st century skills [1]. 21st century skills contain special skills that need to be developed in learning, namely The 4C Skills which means, critical thinking, problem solving, metacognition, communication, collaboration, innovation and creativity, information literacy and others. Problem solving is a strategic competency in the form of applying concepts and skills in understanding and choosing a solution strategy until the problem is solved [2, 3]. Problem-solving skills are the foundation of 21st century skills [4]. In choosing a solution strategy to solve problems with the current rapidly evolving digital era, the field of instructional design has the ability to design, develop, and implement online learning environments [5]. One of the things that is urgently needed in electronic-based online learning is electronic student worksheets [6].

Electronic student worksheet is an interactive teaching material based on digital technology designed to help students in the independent learning process [7]. The combination of the problem-based learning (PBL) model with electronic student worksheet is effective in increasing the active involvement of students in learning, because PBL provides an authentic context that motivates students to solve problems independently [8]. This is also supported by research by the Indonesian Journal of Physics Education Research and Development, which states that the implementation of electronic student worksheet based PBL can improve students' critical thinking and

problem-solving skills in physics materials by involving them actively, collaboratively, and student-centered [9]. Problem-based learning refers to the theory of constructive learning by presenting authentic problems to students, allowing students to build their own knowledge and take teaching independently to solve problems [10].

Previous research shows that the use of technology using electronic student worksheet shows that the results obtained are feasible to improve problem-solving skills [11]. By providing electronic student worksheet, it can also make it easier for students to learn because of its practical nature and attractively presented which can increase the spirit of learning [12, 13]. Other research shows that the use of technology through electronic student worksheet is effective in improving students' problem-solving skills. According to Syaifuddin, et al, the development of contextual-based electronic student worksheet can improve students' problem-solving skills and mathematical self-efficacy [14]. Furthermore, research by Sarman in the "Journal of Mathematics Statistics" shows that the development of electronic student worksheet for building materials for curved side spaces can improve students' mathematical problem-solving skills [15]. Thus, the use of electronic student worksheet not only improves problem-solving skills but also motivates students in the learning process.

Based on the results of the questionnaire analysis of the needs of physics teachers at SMKN 1 Padang, several things that are problems are related to students' problem-solving skills. The results of the questionnaire show that the method used by teachers is still general, namely the teacher center. Learning media in the form of technology does not yet exist. The results of the student needs questionnaire include the low problem-solving ability of students at SMKN 1 Padang. Students at the school still disliked physics lessons with a percentage of 76.92%, they stated that the opinion of physics lessons was difficult to understand. The component of student assessment of teaching materials was obtained by 65% of students having a handbook and 35% of students finding the handbook less interesting. The questionnaire was given to students with results showing students' problem-solving ability in the indicator of identifying problems 31%, the indicator of formulating problems 30%, the indicator of implementing strategies 29% and the indicator of verifying solutions 29% so that an average of 30% was obtained in the less category. The large number of students who still face difficulties in solving problems, as well as the inability of teachers to apply innovative learning models, are two factors that contribute to students' low problem-solving skills [16].

Based on the above explanation, the researcher feels that it is very important to create a teaching material in the form of electronic student worksheet integrated problem-based learning model. Therefore, the title of this research is "creation of an integrated electronic student worksheet problem-based learning model to improve the problem-solving ability of vocational school students."

II. METHOD

This research method uses the eighth edition of Dick & Carey's design model. The Dick and Carey model has 10 phases of instructional design but in this creation model only uses 9 phases. This model begins with identifying needs to determine objectives, analyzing learning tasks, Previous research shows that improving problem solving skills can be achieved through the development of problem-based learning-based electronic student worksheets to improve students' problem solving skills [17]

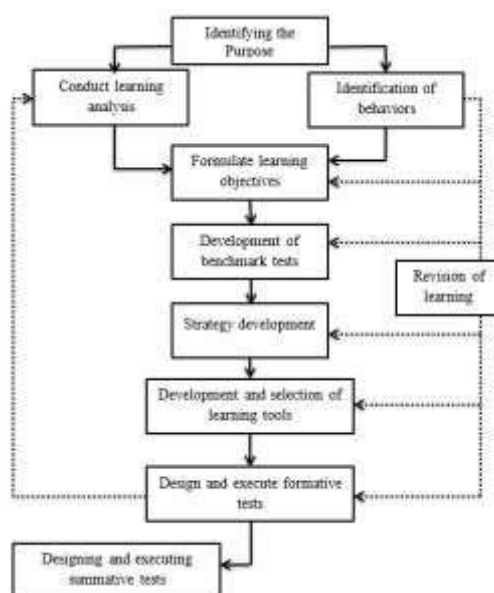


Fig. 1. Model Dick&Carey

The implementation of this research is only limited to the ninth step, which is to make revisions. This validation process was carried out by physics lecturers at FMIPA UNP. The instrument used for the validation of this electronic student worksheets is an instrument that is validated first. This instrument is compiled based on guidelines from the Ministry of Education in 2010. This instrument has six parts, namely the instructional purpose component, the material substance component, the electronic learner worksheets component, the problem-based learning component, the performance component, and the use of software. After being validated by the ahlu staff, then improvements are made based on the suggestions given to produce quality products. After the product was validated, the next step was a practicality test conducted on 24 students of SMK Negeri 1 Padang and 1 science teacher. This practicality instrument includes four components, namely ease of use, learning time efficiency, attractiveness, and benefits.

III. RESULTS AND DISCUSSION

Results

1. Asses Needs to Identify Goals

At this stage, the identification of learning objectives was carried out by means of needs analysis by distributing a needs analysis questionnaire to 24 students and 1 physics teacher at SMK Negeri 1 Padang. Based on the analysis of the questionnaire, it shows that they have not used a learning model that can foster enthusiasm and problem-solving skills. Teachers have not fully implemented IT-based learning and have not stimulated students' problem-solving skills.

2. Conduct Instructional Analysis

At this stage, the researcher conducted the following learning analysis.

Table 1. Learning Analysis Results

Factual	Konseptual	Procedural	Metacognitive
1. Every object in the universe attracts each other with a force that is proportional to the product of its mass and inversely proportional to the square of the distance between them	1. Gravitational force is the Attraction interaction between two mass objects 2. Mass and distance greatly affect Newton's gravitational force 3. The area around a mass object that is still	1. Conducting a discussion about Newton's law of gravity and the strong gravitational field of the earth 2. Presenting the results of the discussion on	1. Summarize the Earth's the law of gravity and the Earth's strong gravitational field. 2. Applying the earth's gravity in daily life

2.	The amount of gravitational force per unit mass at a point near the Earth's surface.	affected by the force of gravity.	earth's matter	gravity
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3. Analyze Leaners and Context

The characteristics of the students in the class, with an average age of 17 years and comprising 22 boys and 2 girls, are well-suited for implementing problem-based learning through electronic student worksheets. Furthermore, a learning context analysis was conducted to evaluate the students' initial abilities, focusing specifically on their problem-solving skills. The results of this initial assessment revealed that the students' problem-solving abilities were relatively low. The findings from the problem-solving ability test are detailed as follows.

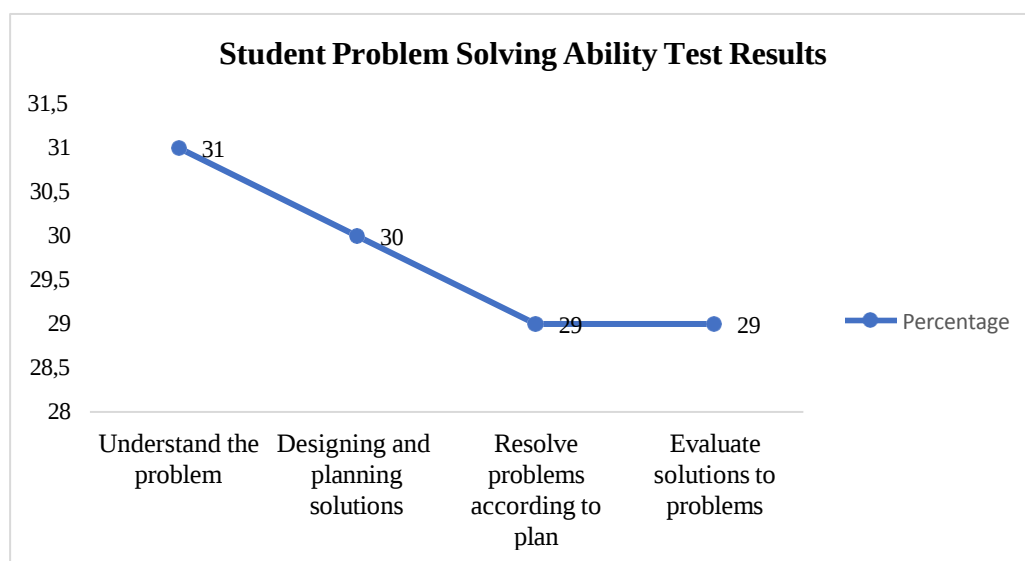


Fig. 2. Results of the Student Problem-Solving Ability Test

Based on fig 2, the percentage of students' ability to solve problems on each indicator can be observed. Based on these results, it was obtained that the value of the student's problem-solving ability was 30% in the poor category.

4. Write Performance Objective

The next stage is to set out the learning objectives. At this stage, the researcher reviews the learning outcomes to formulate the goals that students must achieve after studying the material. The objectives of the physics lesson for the topic of earth gravity are to cover the above:

- Students can explain Newton's concept of gravity in detail, including gravitational force, mass, and distance correctly.
- Students can accurately describe the strength of the earth's gravitational field

5. Develop Assesment Instrument

The fifth step in Dick and Carey's learning design is to develop assessment instruments. These assessment instruments consist of diagnostic and formative instruments. The validity and practicality instruments. The validity and practicality instruments were developed by researchers with the aim of producing electronic student worksheets that are tailored to the needs of learners and able to evaluate the level of validity and practicality of the products developed. Questionnaires are developed based on the data to be obtained and validated by expert lecturers.

6. Develop Instructional Strategy

At this stage, researchers determine the learning strategy that will be applied so that students' problem-solving skills can improve. Learning strategy refers to an organized action plan to achieve learning objectives effectively. In this study, the strategy used is an electronic student worksheet integrated with a problem-based learning model.

The problem-based learning model is conceptual framework that emphasizes the provision of real problems as a learning stimulus, which encourages students to think critically, collaborate, and solve problems systematically. Learning methods that support this strategy include group discussions, information exploration, and presentation of results, therefore students play an active role in the problem-solving-centered learning process.

7. Develop and Select Instructional Materials

The results of various analyzes that have been carried out show that the development of teaching materials is needed that can help overcome the problems experienced by students and teacher in the learning activities. The teaching materials chosen by researchers are electronic learning media in the form of student worksheets. The following is an excerpt from an electronic student worksheet on Earth's Gravity material.



Fig. 3. (a) Electronic Student Worksheets cover page and (b) Navigation page

The electronic student worksheets cover page serves as an initial display that attracts students' attention with a modern and informative visual design. This page features such as the title of the electronic student worksheets, name, school, logo, and relevant illustrations to create a professional and educational impression. In addition, the cover page also includes an "arrow" button to direct students to the next page. Meanwhile, the navigation page serves as the main guide for users to access various electronic student worksheets features. With a simple and organized design, this navigation includes main menus such as electronic student worksheets user manual, learning outcomes, learning objectives, learnign objective flow, electronic student worksheets 1, electronic student worksheets 2, References, and Author's Identity. Responsive navigation ensures that users can easily move between pages and supports an efficient and structured learning experience.

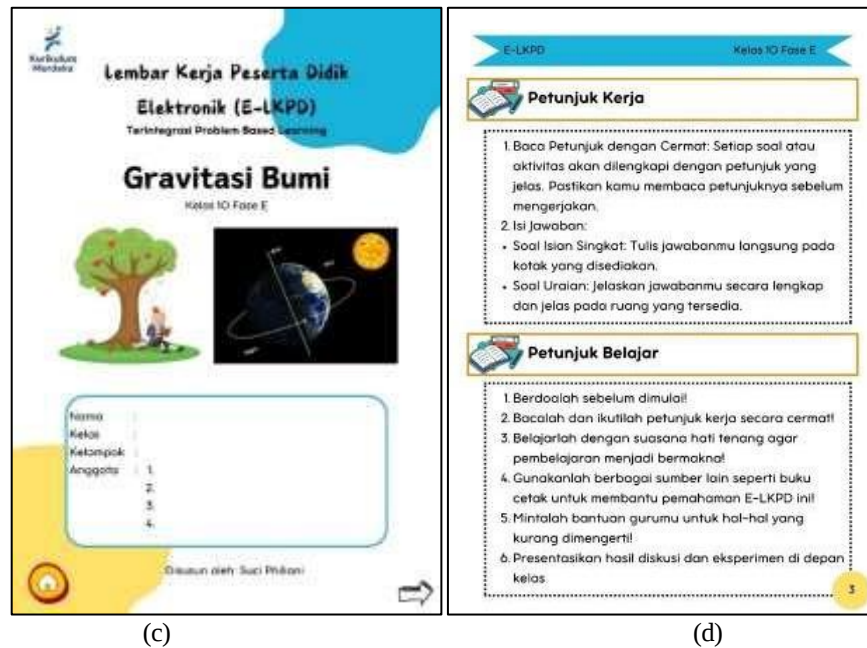


Fig. 4. (a) Electronic Student Worksheets 1 main page and (b) Instruction page

The main page of electronic student worksheets 1 is the main entrance to digital learning activities designed to present important information in a concise and interesting manner. This page usually includes the title of the electronic student worksheets, the name of the material, as well as the main navigation buttons such as "arrow" and "home". The interface is made simple yet interactive, with visual elements that support the user's focus. Meanwhile, the instruction page serves as a step-by-step guide to help students understand how to use the electronic student worksheets. With clear instructions, this page ensures a seamless learning experience, even for first-time learners.

8. Design and Conduc Formative Evaluation of Instruction

After being developed, the initial arrangement will then be validated by 3 expert lecturers. The results of the validation given by the experts in the form of suggestions or comments become a reference for researchers to revise the product. The product eligibility criteria are outlined in the validation instrument questionnaire which is given an assessment score by converting to Aiken's V. The following is a graph of the results of the validation instrument from expert lecturers.

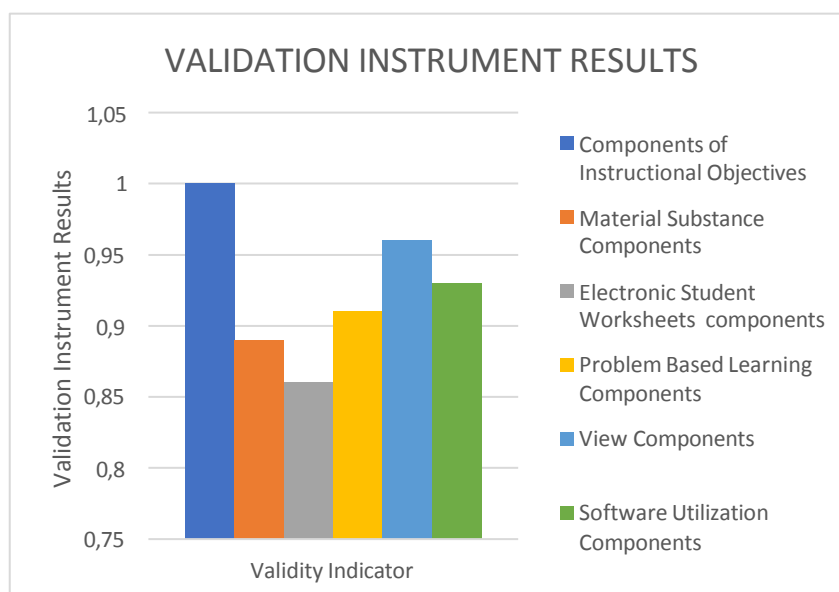


Fig. 5. Validity Results

From figure 5, it can be seen that the values of the validation indicators include 1; 0.89; 0.86; 0.91; 0.96; and 0.93. The average validation result of the electronic learner worksheet integrated with the problem-based learning model is 0.93, including in the very valid category.. So, the validation value of the electronic learner worksheets integrated with the problem-based learning model is at a valid validity for use.

The next stage is product practicality. The practicality test was conducted to recognize the product in terms of ease of use, efficiency of learning time, attractiveness, and benefits. This practicality questionnaire was filled out by 1 science teacher of SMK Negeri 1 Padang and large-scale students as many as 24 students of class X TITL who have learned the material of earth gravity.

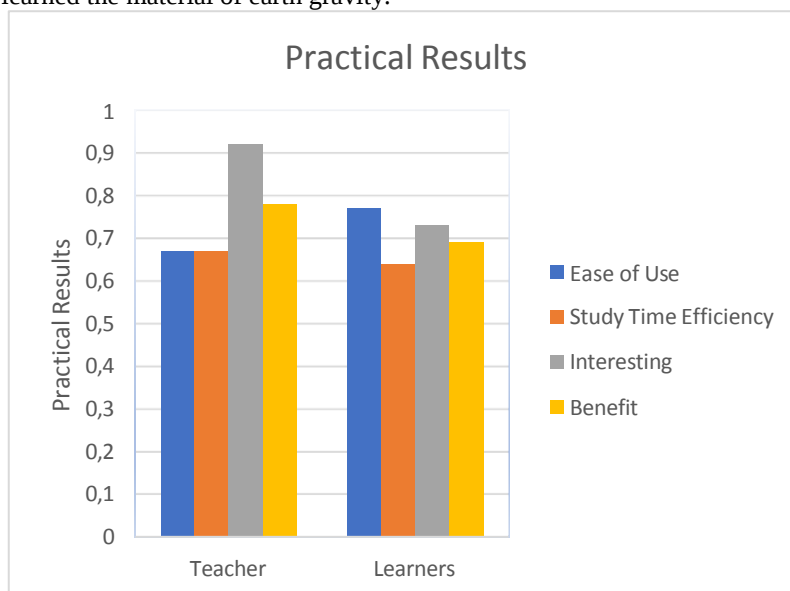


Fig. 6. Practicality Results

Fig. 6 can be seen that the value of the teacher's practicality component includes 0.67; 0.67; 0.92; 0.78 and the value of the student's practicality indicator includes 0.77; 0.64; 0.73; 0.69. The average score of the two practicalities of the problem-based learning integrated electronic student worksheets is 0.74 with the category of quite practical. So the practicality value of electronic student worksheets integrated *problem-based learning* lies in practicality that is practical enough to use.

9. Revise Instruction

At this stage, the researcher summarized the results of both the validator and the formative evaluation in the previous step. Revisions are carried out at all stages starting from conducting needs analysis to continuous formative assessments so that learning can be maximized. Furthermore, revisions are also made to the products produced. Revisions were carried out many times by researchers based on the results of validation from ahlu lecturers to electronic student worksheets which was developed suitable for use. The following are suggestions from validators to revise the products to be developed.

Expert lecturer's advice and comments 1:

- The cover of electronic student worksheets is added with images depicting the material;
- Learning objectives: improve into more effective sentences;
- Electronic student worksheets writing is allowed on every page;
- Problem orientation adapted to real life.

Expert lecturer advice and comments 2:

- Write activities and materials on the electronic student worksheets in a structured manner ranging from easy to difficult, from general to special;
- Discourse on problem orientation is written so that it can lead students to see what the problem is.

Expert lecturer advice and comments 3:

- Add work instructions to electronic student worksheets;
- Turn electronic student worksheets 2 into scientific literature.

Discussion

This is based on preliminary research conducted by distributing a needs analysis questionnaire to teachers and students, as well as a problem solving ability test to identify problems faced by students. Next, researchers began to design products and conduct validation tests and practicality tests of the products made. The validation

test was carried out by 3 validators and physicist lecturers to assess the feasibility of the product based on instructional purpose components, material substance components, electronic student worksheets components, problem-based learning components, performance components, and software utilization. After analyzing the results of the validation test, the results of the instructional objective component were obtained as 1; material substance component of 0.89; electronic student worksheets component of 0.86; The problem-based learning component was 0.91; the display component was 0.96; and the software utilization component was 0.93. So that the results of the validation analysis show that the products made are very valid with an average percentage of 0.93.

The next stage was carried out a practicality test to determine the level of practicality of the product practicality. The results of the product practicality test based on teacher response obtained the following results, namely the ease of use component of 0.67; the learning time efficiency component is 0.67; the attractive component of 0.92; and the benefit component of 0.78. The analysis showed that the product was quite practical with an average of 0.76. Then the product practicality test based on students obtained results, namely the ease of use component of 0.77; the learning time efficiency component is 0.64; the attractive component of 0.73; and a benefit component of 0.69. The results of the analysis show that the product is quite practical with an average of 0.71.

Previous research shows that improving problem solving skills can be achieved through the development of problem-based learning-based electronic learner worksheets to improve students' problem solving skills. In this study, it was successful in improving students' problem solving skills by using electronic student worksheets based on Problem Based Learning through the Classroom Action Research method [18]. Research by Husna also obtained similar results. In his research entitled Development of electronic student worksheets Based on Problem Based Learning to Improve Students' Mathematical Problem Solving Ability by Using the ADDIE Research Method, it was found that this approach was effective in improving students' mathematical abilities [19]. Another study by Sugiyono in his book also underlines that the PBL model can improve critical thinking and problem solving skills in various educational contexts [20]. On the other hand, Hmelo-Silver in her article, asserts that problem-based learning is effective in improving higher-level cognitive skills, including problem solving [21]. Similarly, Barrows and Tamblyn in their book, which mentions that PBL is not only relevant to medical education, but also to problem solving [22]. The research [23] also mentioned that there was an increase in the problem solving ability of students at MAN 2 Gresik. In addition, Trianto in his book Designing Innovative-Progressive Learning Models states that innovative learning models such as PBL can help students understand concepts better through a structured problem-solving process [24]. Additional research by Arends in his book Learning to Teach reveals that PBL helps learners in improving problem solving skills to solve real problems. Arends also emphasizes that PBL strengthens active learning through deep learner involvement in the learning process [25]. In addition, research by Slavin in his book Educational Psychology: Theory and Practice explains that the problem-based learning model provides a meaningful learning experience by involving students in collaborative problem solving, which ultimately improves their conceptual understanding [26]. Another research by Sanjaya in his book Learning Strategies Oriented to Educational Process Standards states that the PBL approach is very effective in helping students develop critical, analytical, and creative thinking skills in solving problems [27].

IV. CONCLUSION

According to the research, the Dick & Carey instructional design model was applied in developing the electronic student worksheets. The validity assessment, conducted using Aiken's V method, resulted in a score of 0.93, indicating a very valid category. Additionally, the practicality score was 0.74, placing it in the practical enough category. Therefore, it can be inferred that the electronic student worksheets, which incorporate problem-based learning to enhance vocational students' problem-solving skills, are both valid and practical for use.

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