Implementation Of STMCpE Textbooks On Students' Problem Solving Skill

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Abstract. Problem solving is a higher level of skill than conceptual understanding. Problem solving skills require a logical process in solving a problem. Problem solving is a higher level of skill than the mastery of concepts that requires a logical process in solving a problem. The purpose of this study was to determine the effect of STMCpE textbook implementation on students' problem solving skills. This research is a quasi-experimental design with nonequivalent control group design. Data collection was obtained from the results of problem solving skills tests conducted in the experimental class and the control class before and after learning. Pretest is used as initial data of student ability and posttest data is used as data to test the effect of learning. Test the effect of learning using ANCOVA. The result showed that the problem solving skills of students who studied with STMCpE textbooks was higher than students with conventional learning with a significance value of 0.000 <0.050. The percentage of effect of the application of the STMCpE textbook was 50.4%. This shows that the problem solving skills of students who learn with STMCpE textbooks are better than students who study using school textbooks.

1. Introduction
Understanding concepts is often associated with problem solving skills. Students who understand good concepts are expected to be able to solve the problems encountered [1;2]. Problem solving skills are one important component in learning [3;4;5]. Problem solving skills are a complex cognitive process [6] that makes it easy for students to find solutions of problems encountered, especially in the learning process [7]. Problem solving is a skill that must be raised in every learning [8], both quantitative and qualitative aspects make students able to analyze problems, plan problem solving, implement problem solving plans, and reflects the results of problem solving carried out by applying it to learning oriented conceptual problem solving abilities [9].
One of the learning oriented skills in problem solving is the STEM approach. STEM is a learning approach that integrates the fields of science, technology, engineering, and mathematics into a whole learning that will develop students' knowledge and skills [10;11;12]. STEM is designed based on the problem solving process as used by scientists [13;15]. The STEM approach is able to create active and cohesive learning because combining these four aspects is needed together to solve problems.

Contextual problems are problems relating to everyday life with situations that are known through thinking flexibly and creatively [16]. In the process of learning science at school, teachers usually present problems to be solved in the form of assignments or problems that must be solved. Contextual problems can help students understand the material being studied and connect the subject matter to its application in everyday life [17;5]. Learning from natural phenomena commonly experienced by students can make students easier to master a material and can do the assignments given by the teacher [18]. Giving contextual problems in learning science is very important, so students can understand the application of science concepts that have been studied [2]. The benefit of providing contextual problems in learning is that it can improve problem solving skills.

The STMCpE textbook on wave material is an attempt to clarify wave phenomena by providing the stages of science, technology, engineering and mathematics in the learning process to assist students in solving contextual problems [19]. Students who are able to develop concepts well are able to solve problems procedurally. STMCpE textbooks are books or materials that contain the process of solving contextual problems so that students are able to solve the problems given by what is seen and understood. Problem solving skills are measured using a rubric adapted from research on conceptual problem solving and problem-solving rubrics by Jennifer L. Docktor. Student answers were analyzed using the rubric of the Minnesota Assessment of Problem Solving (MAPS) which consists of five aspects of problem solving skills, namely useful description, physics approach, specific application of physics, mathematical procedures, and logical progression[6]. This textbook is the result of the development of textbooks that have passed the validity and practicality test from expert and user validators.

Several previous studies have developed STEM learning in various learning resources. The integrated STEM teaching materials developed can improve students' scientific literacy competencies carried out by [17]. Teaching material developed integrates contextual issues in the form of theme projects. Other research is research conducted by [3] which makes STEM modules based on problem solving in the form of themes. The STEM approach has also been investigated by [20] to improve problem solving skills [20]. The novelty aspect that differentiates it from previous research is STEM textbooks with contextual problems created to improve problem solving skills.

Learning by using STMCpE textbooks based on problems is learning that integrates the fields of Science, Technology, Engineering and Mathematics which is oriented to contextual problems. The purpose of this study was to determine the effect and effectiveness of the use of STMCpE textbooks on wave material on students' problem solving skills. It is hoped that the use of STMCpE textbooks on wave material can improve students' problem solving skills.

2. Methods
This research is a quasi-experimental quantitative research with a non-equivalent control group design. The non-equivalent control group design is shown in Table 1.

| Pre-test | Intervention | Post-test |
|---------|--------------|-----------|
| O₁      | X₁           | O₂        |
| O₃      | X₂           | O₄        |

[21]
Information:

\[ O_1 : \text{Experimental Class (STMCpE textbooks) Pretest Score} \]
\[ O_2 : \text{Experimental Class (STMCpE textbooks) Posttest Score} \]
\[ O_3 : \text{Control Class (School textbooks) Pretest Score} \]
\[ O_4 : \text{Control Class (School textbooks) Posttest Score} \]
\[ X_1 : \text{Interventions in the experimental class or class that use STMCpE textbooks} \]
\[ X_2 : \text{Interventions in the control class or class that use textbooks available in schools} \]

Quantitative research subjects were selected in two classes from six classes at grade VIII at Gumukmas Jember 1 Junior High School. The selection of the two classes uses a purposive sampling technique [21] with the consideration that students who are the subject of research have almost the same class average. The two classes selected were made into the experimental group and the control group. Class VIIIA became the experimental group and VIIIB as the control group. Each class consists of 24 students.

Data collection is done by problem solving skills tests. The test is done before and after learning. Assessment of student answers is based on aspects of problem solving, namely useful description, physics approach, specific application of physics, mathematical procedures, and logical [6]. The data obtained were used to test the ANCOVA difference with the prerequisite tests for normality and homogeneity of the data before the difference test was carried out with the conclusion sig.> 0.05. The results of the initial skill test or pretest is used as covariates. Analyzes were performed with SPSS 16.0 for Windows software. Conclusions can be drawn by looking at the significance level stated if there is a difference Sig. <0.05.

3. Results and Discussion

3.1 Results

3.1.1 Pretest and Post-Test Data

Based on the research design, namely the nonequivalent control group design, the test was carried out before and after learning using STMCpE textbooks in the experimental class and school textbooks in the control class. Complete research data can be seen in Table 2.

| Variable | Experimental Class | Control Class |
|----------|--------------------|---------------|
|          | O₁                 | O₂            | O₃            | O₄          |
| N        | 24                 | 24            | 24            | 24          |
| Min      | 40,0               | 71,2          | 46,0          | 60,8        |
| Max      | 66,0               | 81,6          | 65,0          | 78,8        |
| Mean     | 53,6               | 77,0          | 56,0          | 69,4        |

3.1.2 Analysis answer Problem Solving Skills

Student answers were analyzed based on useful description, physics approach, specific application of physics, mathematical procedures, and logical progression can be observed in the bar diagram which can be seen in Figure 1 and the analysis of the answers to each question can be seen in Table 3.
Table 3. Analysis of the answers to each question

| Question | Useful description | Physics approach | Specific application of physics | Mathematical procedure | Logical progression |
|----------|--------------------|------------------|-------------------------------|------------------------|-------------------|
|          | $X_1$ | $X_2$ | $X_1$ | $X_2$ | $X_1$ | $X_2$ | $X_1$ | $X_2$ |
| 1        | 24   | 23   | 21   | 22   | 19   | 20   | 19   | 19   |
| 2        | 24   | 24   | 24   | 24   | 22   | 22   | 17   | 17   |
| 3        | 24   | 24   | 22   | 22   | 20   | 22   | 21   | 21   |
| 4        | 24   | 22   | 23   | 19   | 20   | 19   | 13   | 13   |
| 5        | 24   | 20   | 22   | 16   | 19   | 14   | 17   | 11   |
| Mean     | 24   | 22.6 | 23.2 | 20.2 | 21.4 | 18.4 | 20.0 | 16.2 |

Information:

$X_1 = \text{Experimental Class}$

$X_2 = \text{Control Class}$

Based on Figure 1, the problem solving ability on the concept of vibration and waves has the highest increase in the indicator describing the problem, which is equal to 24.0. It is assumed that indicators describing the problem are maximally trained in learning to use STMCpE-based vibration and wave textbooks. Students are required to understand the problem first before solving the problem at hand. One of the problems to be solved in this learning process is how to make a simple pot modification with a sound attenuation system so as reduce vehicle noise by utilizing the principle of wave interference. This is in accordance with the characteristics of STEM learning which focuses on issues and problems in the real world.

Figure 1. Bar graphs of differences in problem solving aspects of the experimental class and the control class in the Posttest
In learning activities students are trained to solve a problem in everyday life that is contained in the contextual problem shown in Figure 2.

![Contextual Problem](image)

**Figure 2.** Contextual Problem

The engineering activities shown in Figure 3, students are trained to be able to visualize problems by designing tools to be made and preparing work steps. This is accordance with the Useful description indicator, students ability to express or analyze many ideas they have related to a given problem or phenomenon[22].
In the hands-on activity, students make a simple technology product in the form of a simple pot modification according to the design that has been made, as in Figure 3. Tools and materials needed in the manufacturing process, including used cans, scissors, glue, nails, speakers, insulation, hammer, and adhesive. Students test the success of the product by comparing the modified and the unmodified pot. If it produces a smaller sound, the product can be said to be successful. The modified exhaust product is shown in Figure 4.
3.1.3 Analysis of test prerequisites
Prerequisite test analysis is used to determine the type of statistics used. Prerequisite test results indicate that the data are normally distributed, homogeneous, and linear. The results of normality and homogeneity tests can be seen in Tables 4 and 5, respectively.

3.1.3.1 Normality test
Analyzes were performed with SPSS 16.0 for Windows software, with the hypothesis the data is normally distributed with $\text{sig.} > 0.05$ (Table 4).

Table 4. Test results for pretest and post-test normality problem solving

| Variable            | Experimental Class | Control Class |
|---------------------|--------------------|---------------|
|                     | Pretest            | Posttest      | Pretest            | Posttest      |
| Test statistic (sig.) | 0.126              | 0.153         | 0.202              | 0.088         |
| Conclusion (Sig. >0.05) | Normal            | Normal        | Normal             | Normal        |

3.1.3.2 Homogeneity Test
Analyzes were performed with SPSS 16.0 for Windows software, with the hypothesis of homogeneous data if significance $>0.05$ (Table 5).

Table 5. The result for pretest and post-test homogeneity problem solving

| Data       | Sig.   | Conclusion (Sig. >0.05) |
|------------|--------|-------------------------|
| Pretest    | 0.622  | Homogeneous Data         |
| Posttest   | 0.329  |                         |

3.1.3.3 Linearity Test
Linearity data is concluded based on the significance value obtained from the significance value of the deviation from linearity there is a linear relationship. The significance value is $0.599 > 0.05$, so there is a significant linear relationship between pretest and posttest problem solving skills.

3.1.4 Difference test results of the two research groups (ancova)
Significance of ANCOVA test results $0.000 <0.05$ which shows the differences in problem solving skills between students who study with STMCpE textbooks and students who learn to use school textbooks on wave material. The effectiveness value can be seen in the partial eta squared column of 0.504 which means that the STMCpE textbook has an effectiveness of 50.4% in improving problem solving skills. A summary of the ANCOVA test results in both classes of research can be seen in Table 6.
Table 6. ANCOVA test results

| Aspect           | Sig. | Partial Eta Squared |
|------------------|------|---------------------|
| Class Intervention | 0.000 | 0.504               |

3.2 Discussion

The purpose of this study was to determine the effect and effectiveness of the use of STMCpE textbooks on wave material on students' problem solving skills. Differences in treatment were found in the use of STMCpE textbooks in the experimental class and in the control class using textbooks commonly used in schools. Both classes use the same learning pattern or learning model, namely direct instruction. Data collection is carried out before learning and after learning in the chapter wave. Data were analyzed using ANCOVA different test by taking into account the data criteria of normal, homogeneous and linear. ANCOVA results show that there are significant differences in cognitive learning outcomes related to problem solving. Classes that use STMCpE textbooks have higher average problem solving skills with an effectiveness of 50.4% in improving students' problem solving skills.

Data collection is done by tests before and after learning. Analysis of student answers includes aspects of problem solving which include useful description, physics approach, and specific application of physics, mathematical procedures, and logical progression. From Figure 1 it can be seen that all aspects of problem solving with STMCpE textbooks are higher. Improvements occur in all aspects of problem solving. The useful description aspect emphasizes describing the problem. The physics approach uses the physics approach to solve problems. Specific aspects of application of physics use the complete, precise and appropriate application of physics concepts. The mathematical aspect of the procedure uses the appropriate mathematical procedures. The logical progression aspect provides an overall answer to the problem, clear, focused and logical.

In this study, researchers found a pattern that students who mastered the useful description aspect were able to determine the physics approach used to solve the problem. This is evidenced in questions number 1 and 2 in table 2, the number of students who master the aspect of useful description is able to determine the physics approach. However, it experienced some difficulties in the specific application of physics. The same thing happened in numbers 1 and 2 also in the aspect of mathematical procedures and aspects of logical progression. Students who are able to use mathematical procedures will be able to complete the logical progression stage. These results are in line with research conducted by [20] that students who are able to master aspects of problem solving up to mathematical procedures will be able to reach the logical progression stage well.

Contextual problems make it possible to be solved properly using the STMCpE textbook. STEM can improve students' problem solving skills. This is consistent with research conducted by [2] which states that students' problem solving skills increase in classrooms using learning with the STEM approach. Contextual learning also makes it easier for students to apply the concepts being learned in life [17; 4 ;22]. In this study, the level of effectiveness of learning with the STMCpE textbook was sufficiently effective at 50.4%. STEM teaching materials can easily help students provide insight in solving contextual problems. The integration of science, technology, engineering, and mathematics has proven to be able to make students master the skills needed in the 21st century, one of which is problem solving skills [3;17].
4. Conclusions

It can be concluded that the application of STMCpE textbooks influences students' problem solving skills on wave. The results of the hypothesis test statistically with a significance value of 0.000 < 0.050 which means the results of the different tests indicate that classes learning with STMCpE textbooks can improve students' problem solving skills with an effectiveness level of 50.4%. This value indicates that the effect of the intervention given to the experimental class on students' problem solving skills has sufficient effectiveness compared to the control class.

For readers, you should first understand the definition of STMCpE. For advanced researchers, STMCpE textbooks can be applied to measure other skills as research dependent variables, especially variables that are suitable for the needs of students in the 21st century.

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