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CTL-Based Physics E-Book to Improve Students Physics Problem Solving Skills in Senior Highschool

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Abstract: This article reports on the validity of CTL-based physics e-books and the effectiveness of media developed for student problem-solving skills. This research is development research and uses a quantitative approach. The subjects of this research were 17 students of class X science class and 26 students of class X social class at one of the senior high schools in Yogyakarta as the implementation class and modeling classes. The results of this study indicate that the development of a CTL-based physics e-book on simple harmonic oscillation material is feasible in terms of expert validation results where the average total validation score is 3.75 with a very high category. The use of a CTL-based physics e-book in the learning process is able to have a significant influence on improving the problem-solving skills of students in both classes, which is indicated by the value of sig. (2-tailed) of 0.00 both for modeling and implementation classes which are smaller than the alpha value of 0.05.

Keywords: Contextual Teaching and Learning; Physics; E-book; Student Problem Solving Skills

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Introduction

The implementation of physics learning activities in the classroom is one of the challenges that must be faced by physics teachers. Along with the times, learning activities in the classroom no longer only aim to improve learning outcomes, but also must be able to develop the skills that must be possessed by students. These skills will help students to increase the potential of themselves that exist within them and compete in a globalized world. One of the skills that students need to have been the ability to solve problems.

One of the learning objectives in physics learning is to understand the basic concepts of the material studied and be able to apply them in solving problems in the real world (Hegde & Meera, 2012). Problem-solving skills are one of the abilities that affect the student's process in processing the information obtained (L. Hakim et al., 2022). The use of problem-solving skills can help students in solving problems because, with good problem-solving skills, students can excel in facing problems (Klegeris et al., 2017). Problem-solving is one of the important parts of the learning process (Batlolona & Jamaludin, 2022). Teachers can strengthen students' problem-solving skills by providing problems to students that make students analyze and think (Tursucu et al., 2020).

Problem-solving skills are the ability that must be owned by students so that students are able to solve problems well. Indicators in problem-solving capabilities consist of understanding the problems that students faced, creating plans to solve the problem, implementing plans that were created, and reviewing the solutions (Gustafsson et al., 2015; Williams, 2018). Caliskan & Erol states that people who have problem-solving skills will tend to analyze problems first before solving problems (Çalişkan et al., 2010). People who have problem-solving skills will focus on concepts they

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already understand and people with low problem-solving skills only focus on questions and examples that have been described by the teacher before (Mestre et al., 2011). In physics learning, problem-solving skills are needed to resolve the problems in physics learning that students faced (Akben, 2018; Becerra-Labra et al., 2012), especially concepts of physics, students need to understand how to apply the concepts of physics and use the principles and equations of physics (Reddy & Panacharoensawad, 2017). Students need high capability for information analysis and critical thinking to solve the problems that they faced (Syafril et al., 2020).

Teachers as planners and implementers of learning activities should assist students in improving problem-solving skills in physics learning. Unfortunately, pre-research observations show that students still have low skills for problem-solving. Students tend to only be passive in receiving learning materials. Students also have difficulty in dealing with problems that contain the concept of physic, when applying the concepts and knowledge they have in the learning of physics, the student often finds it difficult. Lack of attention to the problem-solving ability of students makes many students difficult in solving problems including understanding and applying physical concepts. Understanding and applying the concept of physics in physics learning is the main point to solving the problems in physics learning (Koponen & Nousiainen, 2013). Understanding and applying the concepts of physics is also one of the main objectives in the study of physics (Taasoobshirazi & Farley, 2013).

CTL (Contextual Teaching and Learning) is one of the strategies that can be applied in the learning process to improve students' problem-solving skills. The CTL learning model is a learning concept that connects the learning material taught and the real situation faced by students (Desnita et al., 2021). This makes the learning material easier to understand with the CTL approach (Yani et al., 2021). The integration of CTL in learning materials also has a positive impact on the development of student's creative thinking skills (Asrizal & Utami, 2021). With CTL-based learning, learning becomes more effective because the learning presented has a relationship with the problems faced by students, the strategies used in CTL-based learning are looking for relationships, experiences, applications, cooperation, and knowledge transfer. Through this strategy, teachers can make students understand new knowledge by connecting the knowledge that students already have (Afni & Hariono, 2020).

Learning strategies with contextual approaches will make students further strengthen, expand, and apply the knowledge gained from school in everyday life (Dewi & Primayana, 2019). Learning with contextual teaching and learning models will provide real experiences that exist around students so that students can see more deeply the problems they face (Hyun et al., 2020; Khotimah & Masduki, 2016; Lotulung et al., 2018). Contextual learning makes the interaction between students and teachers more intensive and creates an engaging and meaningful learning experience(Rahman et al., 2017). Contextual approaches applied in the learning process appropriately will be able to improve the skills that exist within students such as problem-solving skills (Khotimah & Masduki, 2016), critical thinking skills (M. F. Al Hakim et al., 2018; Hyun et al., 2020; Kurniati et al., 2018; Nawas, 2018), and argumentative writing skills (Hasani, 2016).

Seeing the importance of problem-solving skills in physics learning, teachers need to create innovations that can improve students' skills in solving problems in the classroom. One of the innovations that can be done is to develop e-books as teaching materials and learning media. e-books developed must be able to improve students' skills in solving problems during the learning process. In this study, researchers developed a CTL-based physics e-book. the e-book will be developed by applying contextual syntax teaching and learning consisting of constructivism, asking, findings or searching for information, modeling, and reflection. The development of the CTL-based physics e-book is expected to improve student skills in solving problems during the physics learning process.

Method

This research is development research with a quantitative approach. This research aims to develop a CTL-based physics e-book and find out the effect of applying a CTL-based physics e-book on simple harmonic oscillation materials on students' problem-solving skills. Subjects from this research were students of class X social class and science class at one of the senior high schools in Yogyakarta school year 2020/2021. Subjects from this research consisted of 17 students of class X science class as modeling classes and 26 students of class X social class as implementation classes where the selection of subjects was determined by purposive sampling technique(Peers, 2006). This study uses modeling class and implementation class. Modeling classes are early trials of CTL-based physics e-books while implementation classes are further trials after revision based on student responses to the use of CTL-based physics e-books.

The research was conducted in both classes where both classes have the same stage of the learning process. In the first stage, researchers make observations on learning before carrying out the study. Furthermore, the researcher formulates the research problem based on the observations that have been made. In the next stage, the researcher develops a learning medium according to the research problem. In this study, the learning media

developed was the CTL-based physics e-book. After the developed learning media is completed, the researcher validates the media and then revises based on suggestions from validators. Validated learning media are then tested in modeling and implementation classes. researchers conduct statistical tests on trial results to find out the influence of CTL-based physics e-books. The stage of this research is shown in figure 1.

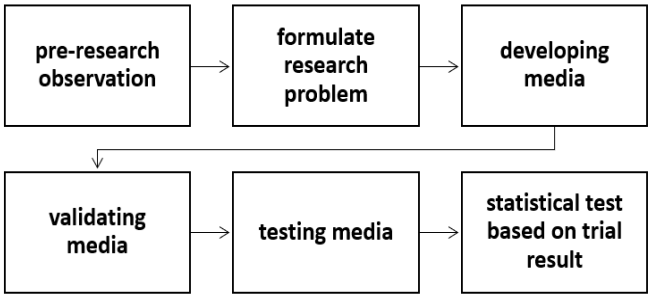


Figure 1. Stage of Research

The form of research in this study is quasi-experiment with one group pretest-posttest research design (Cresswell, 2012). The purpose of using one group pretest-posttest research design in this research is to measure whether there is an influence of CTL-based physics e-books in improving student problem-solving skills. The use of one group pretest-posttest research design in this research because researchers only want to know the effect of using physics e-books based on contextual teaching and learning without comparing it with other media. The use of the research design in this experiment is shown in Figure 2.

O1	X	O2

Figure 2. Research Design

where O1 refers to the pretest score of problem-solving skills, O2 refers to the posttest score of problem-solving skills, and X refers to the use of CTL-based physics e-books.

Learning instruments and research instruments that have been developed before are then given validity tests to find out the feasibility of the learning instruments that will be used in this research. Validity testing is done using the opinion of experts (expert judgment) conducted by two experts. The results of the validity test give the main idea that the learning and research instruments used in this research are fit for use and fall into the very high category. In this validation, the CTL-based physics e-book used validation score conversion based on the mean and ideal standard deviation of the normal curve in Table 1 (Kholis et al., 2020).

Table 1. Validation Score Conversion

Average Score Formulas	Score	Category
X > Xi + 1.80SDi	X > 3.40	Very High
Xi + 0.60SDi < X ≤ Xi + 1.80SDi	2.80 < X ≤ 3.40	High
Xi - 0.60SDi < X ≤ Xi + 0.06SDi	2.50 < X ≤ 2.80	High Enough
Xi - 1.80SDi < X ≤ Xi - 0.06SDi	1.60 < X ≤ 2.50	Low
X < Xi - 1.80SDi	X ≤ 1.60	Very Low

Data analysis techniques in this study used quantitative and qualitative analysis techniques. Qualitative analysis techniques are used to gather pre-research observations and suggestions for improvements to the CTL-based physics e-book. Quantitative data analysis techniques will be used to analyze data from the assessment of student problem-solving skills in modeling classes and implementation classes. Data on student problem-solving skills were analyzed using descriptive statistics and paired t-tests (Cresswell, 2012).

Result and Discussion

Physics e-book that has been developed and then validated by two experts to be assessed eligibility for use along the simple harmonic oscillation learning process. The results of validation analysis on each indicator of the CTL-based physics e-book are converted based on quantitative scores as presented in Table 2:

Table 2. CTL-based Physics E-book Validation Results on Each Indicator

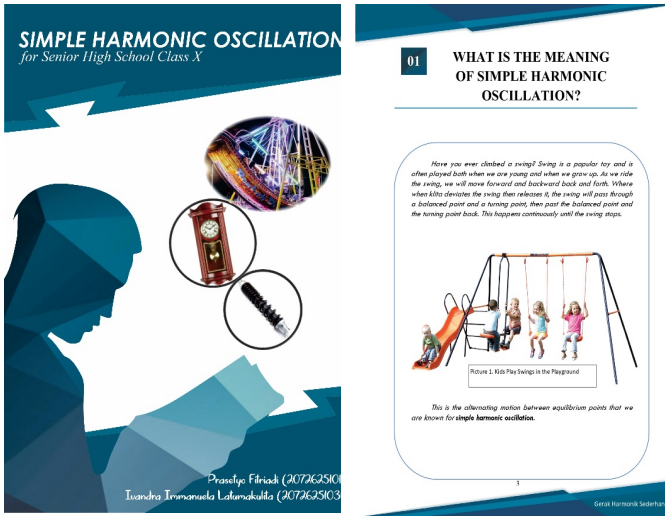
Aspect	Score	Category
Material Completeness	3.88	Very high
Material Support Activities	3.88	Very high
Material Update	3.83	Very high
Presentation Contains CTL	3.67	Very high
Use of notation, symbols, and units	3.50	Very high
E-Book Overview View	3.83	Very high
E-Book Framework	4.00	Very high
Language	3.50	Very high
Average Total Score	3.75	Very high

Validation results show that the average total score on each validation assessment indicator is 3.75 with a very high category. This study also measured student responses to CTL-based physics e-books. Student response to the CTL-based physics e-book is shown in Table 3:

Table 3. Student Response to CTL-based physics e-book

Aspect	Score	Category
E-Book Readability	3.62	Very high
E-Book Overview	3.64	Very high
E-Book Presentation	3.67	Very high
E-Book Ease of Use	3.61	Very high
Average Total Score	3.63	Very high

These results suggest that the developed CTL-based physics e-book is feasible for use in physics learning activities in the classroom. CTL-based physics e-book that had been developed as shown in Figure 3.



(a) (b)

Figure 3. (a) CTL-Based Physics E-Book cover to view and (b) display of material on CTL-Based Physics E-Book

In the next stage, descriptive analysis and sample tests are carried out in pairs in both classes (modeling class and implementation class) to find out the influence of the CTL-based physics e-book on improving student skills in solving the problem. Modeling classes are early trials of CTL-based physics e-books while implementation classes are further trials after revision based on student responses to the use of CTL-based physics e-books. Before the paired test, we should do a descriptive analysis of samples and normality tests first. Descriptive analysis of pretest and posttest of student skills in solving problems in both classes is shown in Table 4.

Table 4: Descriptive Analysis of Pretest and Posttest Results in Both Classes

	Modelling Class		Implementation Class	
	Pretest Score	Posttest Score	Pretest Score	Posttest Score
Minimum Score	3.00	6.00	3.00	6.00
Maximum Score	7.00	10.00	7.00	10.00
Average Score	5.04	8.00	4.94	8.18

The results of the descriptive analysis showed an average for pretest values in the modeling class of 5.04 and an average posttest value for the modeling class of 8.00. Descriptive analysis results showed an average problem-solving skill for pretest grades in implementation classes of 5.04 and an average posttest value for implementation classes of 8.18. These results from both classes showed that there was an increase in the average student's skill in solving physics problems. The results of the normality test are shown in Table 5.

Table 5: Pretest and Posttest Results Normality Test in Both Classes

	Signification Score	
	Pretest	Posttest
Modeling Class	0.12	0.09
Implementation Class	0.17	0.22

The normality test result found that the significance value for the Kolmogorov Smirnov test for the pretest was 0.12 and for the posttest of 0.09 in the modeling class. Both significance values indicate a value of more than 0.05 so this result shows that data from both classes are normally distributed. The normality test result was obtained that the significance value for the Kolmogorov-Smirnov test for the pretest was 0.17 and for the posttest of 0.22 in the implementation class. Both significance values indicate a value of more than 0.05 this result shows that data from both classes are normally distributed. Homogeneity of variance tests is needed to show that the implementation class and modeling class are from the same population. The homogeneity of variance test from both classes is shown in table 6.

Table 6: Pretest and Posttest Results Homogeneity of Variance Test

	Signification Score
Pretest	0.54
Posttest	0.65

The homogeneity test result found that the significance value for the homogeneity of variance test for the pretest was 0.54 and for the posttest 0.65. Both significance values indicate a value of more than 0.05 so it can be concluded that both data are from the same population. This result shows that data samples from both classes can be tested for paired t-test samples. The results of the paired t-test sample are shown in Table 7.

Table 7: Test t Paired Samples in Both Classes

	Modeling Class	Implementation Class
Mean Score	-2.96	-3.24
Standard Deviation	0.20	0.44
T-test Score	-77.00	-30.51
Significance (2-tailed)	0.00	0.00

The paired sample t-test results gave a significance value (2-tailed) of 0.00 in modeling class which was smaller than 0.05, these results show that there is a difference in the average student's skills in solving problems during the learning process by applying CTL-based physics e-book that has been developed in

modeling class. The paired sample test results in the implementation class showed a significance value (2-tailed) of 0.00 which was smaller than 0.05, this result shows that there is a difference in the average problem-solving ability during the learning process by applying the CTL-based physics e-book that has been developed in the implementation class. A negative t value indicates that the average pretest value is smaller when compared to the average posttest value. The average comparison graph of pretest and posttest scores in both classes is presented in Figure 4.

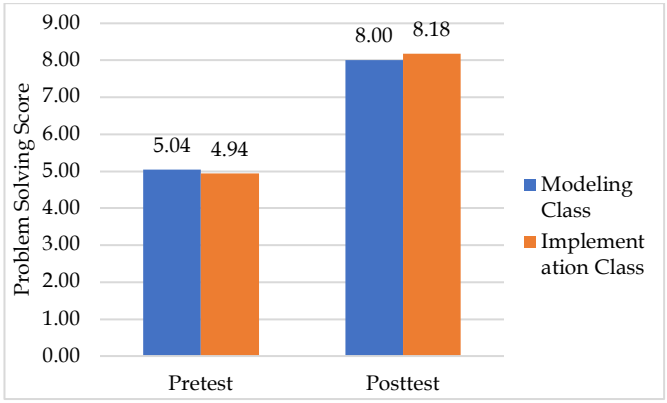


Figure 4. Average Score of Problem-Solving Skills in Both Classes

The results of the paired sample test for both implementation classes and modeling classes have a small significance value so it can be stated that learning and applying contextual teaching and learning-based physics e-books has a significant positive influence on improving high school student problem-solving skills in simple harmonic oscillation materials. Physics learning using the physics e-book based on contextual teaching and learning applies contextual teaching and learning syntax consisting of constructivism, asking, finding, or searching for information, modeling, and reflection. This contextual teaching and learning syntax indirectly helps students to develop their skills in solving problems where students are asked to understand problems, plan solutions, solve problems, and re-check. The CTL-based physics e-book that has been developed contains simple harmonic oscillation material that is associated with events around students in everyday life. This makes the learning process run interestingly and the learning materials delivered by teachers are not abstract for students because they relate to real events that exist in everyday life (Hyun et al., 2020; Khotimah & Masduki, 2016; Lotulung et al., 2018). Physics learning using e CTL-based physics e-book combines physics knowledge they possess and the application in daily life. Students would try and experience it by themselves thus students will easier to understand the physics concept in their daily lives (Dewi & Primayana, 2019). This makes learning by applying CTL-based physics e-books can improve student skills in solving problems.

Conclusion

The development of a CTL-based physics e-book on simple harmonic oscillation materials is worth using in terms of expert validation results where the average total validation score of 3.75 with a very high category. The use of e CTL-based physics e-book during the learning process can have a significant influence on improving problem-solving skills owned by students in both classes shown with sig values. (2-tailed) of 0.00 is good for both classes which are smaller than the alpha value of 0.05. The application of a CTL-based physics e-book can be an alternative solution for physics teachers to improve student skills in solving problems.

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