Scaffolding computer packet instruction (SCPI) to analyze student’s problem solving performance on physics

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Abstract. The development of technology could facilitate individuals to access information, solve problems and communicate. This physics education research, the author wants to convey the impact of utilization quantitatively and qualitatively scaffolding of computer packet Instruction (SCPI) on students' problem solving performance. SCPI learning packet consists of material, Check your knowledge, feedback and evaluation buttons. The research method used is a mixed method embedded design. The participants in this study were 32 students in class X MIA 1 ISLAM PUJON SMA MALANG. Students consist of 10 male and 22 female. The study was conducted in the even semester of the 2017/2018 school year with topics of work and energy topic. Quantitative data analysis through calculation of N-gain test, effect size test and paired t-test. Based on Quantitative analysis results, the use of SCPI media could have a positive impact on students' physics problem solving performance. This result is supported by data on the increase in pretest and posttest values. The statement was also supported by students' responses in filling out the online questionnaire that there was an increase in independent learning capacity after SCPI was implemented in the concept of solving students' physics problems.

1. Introduction
The era of the industrial revolution 4.0 is a new pattern of civilization in facing new challenges at the global competition. The most common impacts are shifts in mindset, behavior patterns and speed of getting information sources. Therefore, some aid tools can be used as intermediaries to that era. One of them is in the form of information technology-based media implementation. In learning systems, the use of media can facilitate communication, learning resources or as a learning tool[1]. Educational institutions at both the secondary and tertiary levels are intensively transforming the learning system into student centered. Students are expected to be able to learn independently, without depending on the teacher. Independence in this case, students are able to get sources of information through assistance in the form of media. One form of solution to realize this is by utilizing information technology as a scaffolding for teachers and students[2].

Scaffolding is one of the aid tools used in collaborative learning involving teachers or groups of students by utilizing[3]. Scaffolding referred to in the learning system can be either manual or computer media[4]. Computer assistance is not only for presenting material, but also contains several other components such as learning evaluation or feedback format. Some previous studies only present one part of these components, [5]only integrates physics material in the form of e-learning, [6]only develops learning assessment in the form of e-learning without the feedback format of the teacher.
In terms of evaluation, the teacher has limited instruments and analytical tools faced by the teacher in carrying out formative assessments[7]. The implementation of formative assessment is less significant in the learning process. The teacher cannot obtain information about the strengths and weaknesses of student learning, as a result the teacher has not obtained clear guidelines in following up on the learning outcomes. Likewise with students, they do not get adequate feedback about their learning outcomes. Development of e-learning with incomplete substance causes interest in learning and changes in students’ physics concepts to be weak[8]. The study conducted by states that students who have misconception problems in learning experience literacy problems, problem solving performance and metacognitive problems. e-Learning offers strategies to enable students to be very independent, this will help them enjoy better learning effectiveness[9]. The characteristic that is formed in students is that they can use independent learning habits not to repeat mistakes.

Research conducted in the last few decades shows that teachers did not yet have competencies in some physics learning that include learning packages starting from material preparation to the feedback format (assessment for learning)[10]. Teachers and students alike need information about how technology is capable of all of them. Some of the weaknesses of scaffolding-based computers that have been developed in previous studies include; First, the studies presented are only like one content such as material only or only animation media. Second, the physical content that is displayed is incomplete, so that it did not attract students' interest. Third, when evaluating learning outcomes it is not an application of feedback for students. Feedback serves as a reflection material evaluating related to concept errors or helping to solve physics problems. Third, the scaffolding given has not yet completely corrected the wrong concept in students.

The physics packet offered consists of study material, formative assessment equipped with feedback and summative test in the form of description questions. The feedback format offered in formative assessment is an exercise to overcome misconceptions in physics concepts. Learning packet are exercises to enable students to construct knowledge according to their level of thinking. Based on observations in the class X of Islam Pujon Malang Senior High School, Teacher activities were more dominant compared to students. The teacher only chooses e-learning as a tool to evaluate student learning outcomes in the form of electronic report cards and in presenting material only in verbal form without the help of any equipment. Therefore, in this study with the aim of developing a physics learning system that integrates material presentation, formative assessment based on feedback format to improve students ‘ability to solve physics problems and their influence on students’ problem solving performance.

2. Scaffolding Computer Packet Instruction (SCPI) on Physics Learning

Scaffolding In this study has the meaning as a medium designed on computers in learning systems. Media on computers is expected to be able to help students solve student problems in learning physics. Scaffolding integration in physics learning can be used as an analytical tool to help gain a better understanding of how boundaries limit the teaching content of physics[11]. Therefore, there are several feature features that need to be considered in scaffolding learning, namely; 1) Learning Content (for example, problems or questions posed by teachers related to teaching material), 2) Learning Independence of Physics (for example, thinking skills, concepts and understanding) ability to solve problems; 3) Evaluation of learning physics in terms of students and teachers (for example, how to evaluate, type of evaluation and usefulness of evaluation) 4) Context of learning (for example, quality of learning activities, student social background and student understanding.

In the development and implementation stages, computer-based scaffolding can be started with the following stages. First, the survey phase, in this study the study of what things are a problem in the scope of physics learning. The analysis in the survey phase examines the characteristics of the material, the classroom learning system, the teacher and students. Second, the stage of implementing, at this stage, designing an application that will be used to enter elements in the survey stage. Computer applications used use powerpoint version 13.0. After the application is completed, the next stage will be converted into a media player format to make it easier for students to run. Third, the action stage,
the teacher explains how to use the product, complete the product and test the product on students. The following is the front view of the SCPI that has been made on work and energy material.

Figure 1. Front of SCPI

Figure 1 is a front view SCPI media when it starts on the computer. SCPI consists of main buttons and supporting buttons. The main button consists of material buttons, Check your knowledge, feedback and evaluation. The main key function is to run the SCPI system according to their respective tasks. The support button consists of the home button, home button and sound button. The home button works to restore the display to the home page. Sound button to run music while the application is running. Close button to close the slide show that is being run simultaneously. The material consists of learning objectives and material for four meetings. The first meeting discussed work material, the second meeting of energy, the third meeting of energy work relations and the fourth meeting of the energy concept. At the end of the meeting, the teacher evaluates with multiple choice questions through the "check your knowledge" button. Figure 2 is a display when students start working on the final evaluation of the meeting.

Figure 2. Display of Check Your Knowledge Button
Figure 2 displays conceptual questions to find out how much students understand about physics. If students can answer correctly, the student is considered to have sufficient knowledge to continue learning and testing in the next topic. If students only answer less than 60%, then the display automatically appears to go to the scaffolding button. This indicates that students do not fully understand the material. The role of the teacher directs students to press the scaffolding button. The scaffolding display summarizes the conceptual material presented by the teacher and relates to material that is not yet understood by students. Students who will reach the standard after learning the scaffolding will go to the problem solving ability test button.

Figure 3. Example of Display on the Button If Students Have Reached the Standard

Figure 4. Example of Display of the Feedback Button If Students Have Not Reached the Standard
3. Student’s Problem Solving Performance On Physics

Study of definition of problem solving skills refers to the procedure steps taken by individuals in achieving the expected solutions. Important competencies are implemented by students in solving problems. The ability to solve learning physics helps students use procedural skills related to how to solve physics problems[12]. The cognitive domain of problem solving skills is categorized as high level thinking. students solve problems by involving deep thinking activities, presenting contextual facts as additional information and strengthening arguments at temporary conclusions before evaluating the correctness of the solutions offered. Each individual has two forms of characteristics in terms of problem solving skills, namely knowledge and process[13]. In the context of knowledge, individuals are expected to be able to practice in terms of the ability to read, understand, recognize numbers or similarities and basic knowledge of science. In the process context, individuals are expected to be able to recognize procedures, evaluate and connect prior knowledge.

Some previous research studies in identifying problem solving performances, participants have two types in solving problems, namely: structured and unstructured problem solving[14]. Unstructured problem solving capabilities include several steps that are passed, namely; represent the problem, find solutions, and implement solutions. The structured split ability aspect describes seven steps in the problem solving cycle that are more detailed in solving problems, namely: problem identification, problem definition, strategy formulation, information organizing, resource allocation, monitoring, and evaluation. In physics learning, students’ problem solving skills need to be evaluated with several methods developed based on the needs and characteristics of each problem. The purpose is to evaluate the problem solving ability so that the teacher can find out the progress of student learning and make advances in improvement in subsequent learning. Researchers have developed indicators of evaluation of problem solving abilities. [15] describe the ability of physics problem solving to be evaluated using several stages outlined by several indicators in Table 1

| Indicator          | Description Of Performance                                                                 |
|--------------------|------------------------------------------------------------------------------------------|
| Identify problems  | Identify problems based on basic concepts such as the magnitude of problems, both asked and those that are known to synthesize existing problems (citing or representing problems) |
| Defining problems  | Describing variables in problems Determining solved physical scale                        |
| Planning strategy  | Determining an equation or an important concept to solve a problem                        |
| Implementing strategy | Substituting the value of a known quantity to an equation Calculating using the chosen equation |
| Evaluating strategy | Evaluating conformity with concepts and logical answers Evaluating conformity with units |

4. Methods

4.1 Design of The Research

This study was designed through a research mixed method with the design of embedded experimental models. The implementation of this type of research can be seen in Figure 5. The basic framework adopts this research approach to be adjusted to the formulation of the problem proposed in the introduction. The purpose of this study is to describe how the quality of students’ problem solving skills is quantitative and qualitative through the SCPI learning system. The data obtained is not just a single data, but some data that is interpreted simultaneously in the form of narration, numbers or images.
4.2 Participants

Participants are information on the number and gender included in the study. Other things are also related to information on the place and time of conducting research. Subject in this study was the X class MIA Pujon Malang Islamic High School. Selection of research subjects through **purposive sampling technique**. This technique is done by selecting research subjects by deliberately taking a certain number of participants with the criteria and information desired by the researcher. participants were 32 students in class X MIA 1. Students consisted of 10 men and 22 women. The study was conducted in the even semester of the 2017/2018 school year with topics of work and energy.

4.3 Instruments and Data Analysis

The research instruments consisted of structured interviews and problem solving ability tests. Structured interviews are short questions that are presented in the google form containing 10 items. The problem solving ability test consists of 5 items in the description. Before the research was conducted, both instruments were tested for validation and reliability by physicists and empirical studies. Based on the test results show the value of empirical validity and reliability. The assessment of problem solving performance follows the rubric; Identifying Problems (A1), Defining the Problem (A2), Planning Strategies (A3), Applying the strategy (A4), Evaluate solution (A5). All of the rubric have five level criteria of problem solving performance that are level 1 up to level 5.

Consists of interpretation of qualitative data and quantitative data simultaneously. Qualitative data analysis uses descriptive techniques. Quantitative analysis uses the effect size statistical test, paired t test and N-Gain in order to determine the changes and the effect of the value of problem solving performance on the pre-test and post-test data after the implementation of the SCPI. Before being used, the quantitative data was first tested for the precondition of homogeneity and normality of SPSS 18.00 version.

5. Result And Discussion

Data problem solving performance is the data from the pretest and posttest of students. In this section, the data on problem solving capabilities are described based on the calculation of the total score and coding of the data pre-test and posttest. Statistical tests were used to answer problem solving abilities before and after learning to use SCPI.

The following are the results of the normality and homogeneity test results of the pretest and posttest of students' problem solving abilities in table 2.
Table 2. Statistic Result Of Problem Solving Performance Data

| Description               | Pretest | Posttest | Conclusion Data |
|---------------------------|---------|----------|-----------------|
| Mean                      | 19,31   | 61,56    | Strong          |
| Standard Deviation        | 4,087   | 12,01    |                 |
| Maximum Value             | 26      | 84       |                 |
| Minimum Value             | 11      | 40       |                 |
| Normality (Significance of shapiro wilk) | 0.158 | 0.177 | Normality Data |
| Homogeneity (Significance) | 0.159   |          | Homogen Data    |

Information Table 2 shows that the pretest and posttest data on problem solving skills have a shapiro wilk significance value of 0.158 for the pre-test data and 0.177 for the posttest data. The data obtained will be normally distributed with the criteria if the significance value can be equal to or greater with \( a = 0.05 \). The results obtained in this study show the significance value of posttest and pretest is greater than 0.05 (pretest data: 0.158 > 0.05 and posttest data: 0.177 > 0.05), so the conclusion is that the pretest and posttest data on students' problem solving abilities came from populations that were normally distributed. The homogeneity test results showed a significance value of 0.159 for the posttest data. This shows that the posttest data is homogeneous (0.159 > 0.05).

The next stage, to find out the influence of SCPI learning on problem solving assisted skills, then continued statistical tests. Advanced statistical tests include the effect size test, N-gain test and paired sample t-test. The three tests have the purpose of describing an increase in students’ problem solving abilities before and after the intervention. The following are the results of the advanced statistical tests on the problem solving ability data in Table 3.

Table 3 Description of Test Results Statistics Ability to Solve Problems Students

| Test Advanced Statistics | Value | Category Value |
|--------------------------|-------|----------------|
| Test Effect Size         | 4.29  | Strong         |
| N-gain                   | 0.522 | Moderate       |
| t-Test Paired Sample     | 0.002 | difference Significant |

Table 3 shows that the pretest and posttest data on problem solving performance has a significance value of the advanced statistical test with each value of 4.26 for the calculation of the effect size test with an indication of the category of increased pre-test and post-test results with a strong category. The calculation of the N-gain test has a value of 0.509 with the medium category. In the calculation of paired t-test, it is explained that the hypothesis is accepted if the t-count value is smaller or equal to 0.05. The results of paired t-test calculations show that the calculation value has a significance of 0.002 <0.05, so it can be concluded that there are significant changes. Based on the three data from the results of the advanced statistical tests, it can be concluded that the positive influence of the application of SCPI in physics learning has a positive impact on students.

The following is an example of student responses and categories of student performance levels in solving physics problems.

Table 4. Example Of Student Answer Categories

| Example of questions         | Coding Students’ Answers                                                                 | Level of Performance solving physics problems of students |
|------------------------------|----------------------------------------------------------------------------------------|----------------------------------------------------------|
| Astronaut have orbit satellites on Earth's | Students are able to explain that the satellite motion to apply the concept of operations | Level 5                                                  |
that the direction of the force of gravity to transfer the satellite perpendicular so that based on their relationship with the work, then the work done by the satellite is zero.

Students only draw correctly and complete with a description direction of movement of the satellite and the gravitational force, but without an explanation of details  Level 4

Students only give a short answer that \( W = 0 \)  Level 3

Students answer briefly but are not correct  Level 2

Students do not respond at all  Level 1

Based on student information in filling out online questionnaires that use SCPI in physics learning is very effective. This is expressed by three indications as follows: First, indications of media renewal. In this indicator, 84% of students answered that the media used was quite new and interesting to learn. Learning in the class that previously only used oral presentations from the teacher was not satisfying for students. Second, the aspect of the use of media, on this indicator students give more reason that the SCPI media is able to provide many ways in learning styles. Third, Media Content, on this indicator, students are more interested in the scaffolding button in the form of feedback from the teacher. Their reason is that the feedback format is able to evaluate their own understanding. But there are some suggestions given by students that there is not integration of evaluation for problem solving performance test. Based on the acquisition of the overall score, the students' problem solving performance changes significantly. In detail, student scores can be seen in the following the graph.

**Figure 6. Distribution of Problem Solving Performance Data**
Based on the acquisition of data in graph 1 shows that the average problem solving ability of students is classified as being in the medium category. This is evidenced by the significant changes in student answers at the pretest and posttest. The presentation of the SCPI tutorial in the form of procedural and conceptual is able to open the horizons of students to be more courageous in trying to work on the problem solving performance. Students can re-understand the physical concepts that are re-learned through scaffolding[16][17]. This kind of learning variation can help students not only do quantitative type questions, but also problems related to phenomena that require basic concepts of physics. Qualitative issues have advantages in activating students' functional cognitive structures including reasoning pedagogics, conceptual changes and application of physics concepts [15]. Students with problem solving skills both try to solve problems using the problem solving ability procedure and assume the solutions offered are effective. When students interpret information on a problem, they indirectly use a factual frame of mind in defining a problem [18]. This makes students' thinking focus and the problem solving process is directed at one right solution. It is different from students who have less problem solving skills, they use intuitive thinking in solving problems.

6. Conclusion
The Using of technology in learning is very beneficial for the continuity of learning in school. One application is the use of SCPI media in physics learning. The results of the study showed an increase in the results of students' problem solving abilities after the application of the SCPI media. This is evidenced by the results of the increase in the value of the results of the students' pretest and posttest and the indication of satisfaction for students through the response to the online questionnaire. But in this study, researchers are still limited to only using media as scaffolding. In evaluating problem-solving abilities it cannot be integrated in SCPI media, because SCPI is still limited to evaluating multiple choice questions.

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