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# Profile of Students' Problem Solving Skills and the Implementation of Structured Inquiry Models in Senior High Schools

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## Abstract

This study aims to get a profile of students' problem-solving skills and the implementation of structured inquiry models in senior high schools. This type of research used in this study is preliminary research, with data collection techniques in the form of student interview questionnaires, teacher interviews, and written tests. Then the data that has been obtained will be analyzed descriptively qualitatively. This research was conducted on 24 students of class XII-SCIENCE in one of the high schools in the district of Gresik. Based on the results of the study found findings in the form of 1) The ability of students to solve problems in the low category with a range of grades from 0 to 1.00 as many as 11 students and the medium category with a range of grades from 1.01-2.00 as many as 13 students, 2) Criteria for the lowest problem-solving skills at point A- Assen the problem (Identifying the principles of the problem needed to solve the problem) with an average value of 0.375, 3) The application of structured inquiry models is expected to be able to improve problems solving skills possessed by students. It can be concluded if the problems solving skills possessed by students are low, so it is necessary to increase the problems solving skills of students by using new learning methods that have never been taught to students.

**Keywords:** PhET; Problem Solving Skills; Structured Inquiry



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## INTRODUCTION

Learning is an activity carried out by humans to achieve competence, skills, and attitudes. By learning someone will get knowledge based on the experience that has been passed, based on that experience can make someone have a sharper memory. Learning can also provide information that is not yet known, from the information that has just been found, can be found a new thing that is not yet known. So, by learning someone will discover new things. Learning has many benefits, both for yourself and others. For yourself, regular learning will contribute to the quality of life. As for others, learning plays an important role in the spread of culture and knowledge from generation to generation (Baharuddin & Wahyuni,

2015). Situations in the classroom when the learning and teaching process takes place can affect student learning outcomes. Of the many learning outcomes that can be achieved by students, one of which must be possessed is problems solving skills. Problems solving skills that are at the core of this research are conditions that have no known exit or escape scheme (Primadani, Tukiran, & Jatmiko, 2016a). Problems solving is a combination of thoughts to form a combination of several new thoughts, to combine thoughts and lead them to solve problems more focused on reasoning. Problems solving can also be interpreted as an effort to find a solution to a difficulty to achieve the goals to be achieved and is closely related to the thought process, learning, memory, transfer, perception, and motivation (Aisyah, 2016). It can be said that problems solving skills are the level of human ability for his efforts to find solutions to the problems being faced through various stages to achieve the goals to be achieved. Problems solving ability can be assessed based on 5 (five) aspects of ACCES, namely: 1) Assisting the problem 2) Create a drawing 3) Conceptualizing the strategy 4) Execute the solution 5) Scrutinize your result (Teodorescu, Bennhold, Feldman, & Medsker, 2013).

Based on preliminary studies that have been conducted at Senior High School 1 Driyorejo through questionnaires interviews and practice questions on students obtained results in the form of 1) Students have not been able to identify the principles of the problem needed to solve problems that have an impact on aspects of problems solving 2) Students less complete in translating words in the form of pictures or pictures that contain instructions 3) Students have low confidence in their ability to solve problems 4) There is a disagreement between students and teachers about the feasibility of learning using a virtual laboratory (PhET) 5) Practicum never done in a laboratory.

The learning model carried out by the teacher sometimes does not match what is stated in the lesson plan. Teachers more often teach using conventional learning methods. According to an interview that had been conducted together with the teacher concerned, it was found that students rarely even did lab work in the laboratory because there was construction in the school which caused the laboratory to not function properly. To overcome these problems, offered learning models that have never been taught, namely using structured inquiry assisted by PhET to improve the ability to solve physical problems possessed by students.

Guided inquiry learning is a learning model that has been developed for teaches the students how to think (Baharuddin & Wahyuni, 2015). The inquiry is learning that is based on the basics of scientific thinking in students. In the learning process, students are required to be independent, which is by learning by themselves and developing their ability to solve problems (Primadani, Tukiran, & Jatmiko, 2016b). If students have never been taught by using inquiry learning methods, structured inquiry learning models can be used. Based on the explanation above, the main objective of this study is to determine the profile of students' problems solving skills and the implementation of structured inquiry models in senior high school.

## METHOD

This type of research used in this study is Preliminary Research. Where the research activities are descriptive and not to test a hypothesis. The results of this study will be used to consider developing learning methods that can

improve students' problems solving abilities.

The research was conducted at Senior High School 1 Driyorejo with the subject of the research being 24th-grade students of XII-MIPA4. The research time will be conducted in the even semester of the 2019/2020 school year on 26 February 2020. Data analysis techniques using student interview questionnaire and teacher interview, and written test.

The questionnaire is used to find out a description of the conditions and learning outcomes that have been done by students, teacher performance, as well as the condition and utilization of existing facilities and infrastructure. To obtain data on these aspects, a questionnaire containing four questions will be filled out by students.

Interviews with teachers were conducted to dig deeper into information about the activities of teaching and learning that have been done. This interview is also useful for synchronizing answers between students and teachers. The information that was explored is about: teaching problems solving skills, whether or not an experiment has been carried out; whether or not teaching about the steps of scientific research, as well as whether or not the teacher introduces students to the visual laboratory application (PhET).

A written test is a test in which the answers and questions are in the form of writing. In answering problems, students not only write answers with sentences but can also go through pictures, give signs, make graphics, etc. Written tests are used to explore data on which problems solving skills students have. The instrument used was in the form of a description of the work done on the answer sheet that has been listed criteria for assessing problems solving skills (ACCES).

Data analysis techniques that will be used in research time this a qualitative descriptive analysis. The analysis is used because the researcher wants to describe and describe the facts and the actual situation.

## RESULT AND DISCUSSION

The results of the research that has been done are aimed at finding out the real situation, regarding problems solving skills possessed by students, especially on the subject of Dynamic Electricity. The study was conducted by giving students three questions about dynamic electricity, which were equipped with answer sheets that had the problems solving skill criteria (ACCES) listed. Besides, a student interview questionnaire was given, which consisted of four questions regarding problems solving skills, scientific experiments, and virtual laboratories (PhET).

### Problem Solving Skills Test

Based on the research that has been done, the results of the problem-solving skills test are obtained as shown in Figure 1.

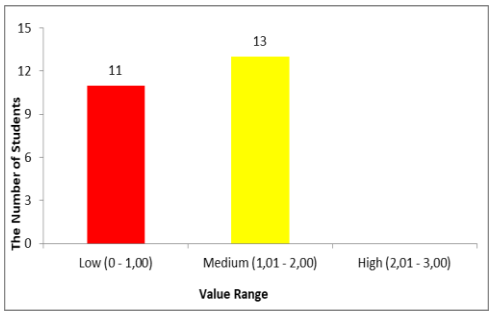
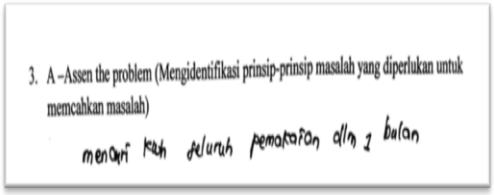



Figure 1 Figure relationship between the value range and the number of students

Based on assessments that have been made using logical, complete, and systematic criteria, a maximum score of 3.00. Figure 1 shows if the student's ability to solve a problem is still low. The ability of students to solve problems in the low category with a range of grades from 0 to 1.00 as many as 11

students and the medium category with a range of grades 1.01-2.00 as many as 13 students. The first thing that can be done to overcome these problems needs to be known in advance, the cause of students difficulty in solving a problem. To find this out, a problem is provided, which is equipped with an answer sheet that has listed the criteria of problems solving skills (ACCES). The criteria for problems solving skills are:

1. A–*Assess the problem* (Identify the principles of the problem needed to solve the problem)
   The following examples of student answers on A-Assess the problem can be seen in Figure 2.

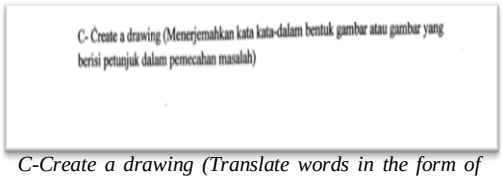



*A-assess the problem (Identify the principles of the problem needed to solve the problem): find kWh all usage in 1 month.*

Figure 2 A-assess the problem

In Figure 2 it is found that students do not understand the concept behind the problem. The underlying concept of the problem is to use the concept of power.

2. C–*Create a drawing* (Translate words in the form of pictures or drawings that contain instructions in solving problems)
   The following examples of student answers on C-Create a drawing can be seen in Figure 3.

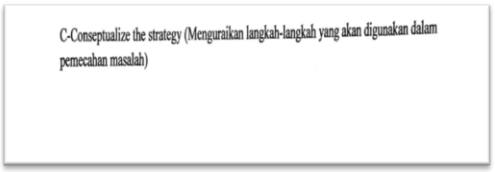



*C-Create a drawing (Translate words in the form of pictures or drawings that contain instructions in solving problems)*

Figure 3 C-Create a drawing

On these criteria, there is indeed no information that can be changed into the form of images. However, existing information can be presented in tabular form to facilitate students in obtaining information. As can be seen in the Figure 3, that students leave the answer sheet blank in that section.

3. C–*Conceptualize the strategy* (outlines the steps that will be used in solving the problem)
   The following examples of student answers on C-Conceptualize the strategy can be seen in Figure 4.

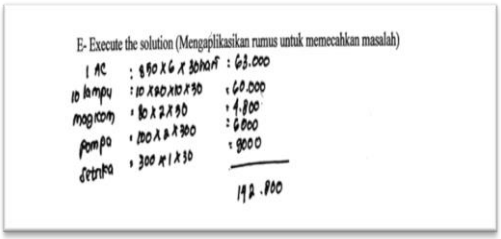



*C-Conceptualize the strategy (outlines the steps that will be used in solving the problem)*

Figure 4 C-Conceptualize the strategy

In Figure 4 show that in the description of the steps to solve the problem, there is no answer in that section. Students prefer to leave the section blank. That can happen because students from the beginning did not understand what concepts contained in the problem. So students do not know what steps can be used to solve these problems.

4. E–*Execute the solution* (Apply the formula to solve the problem)
   The following examples of student answers on E–Execute the solution can be seen in Figure 5.



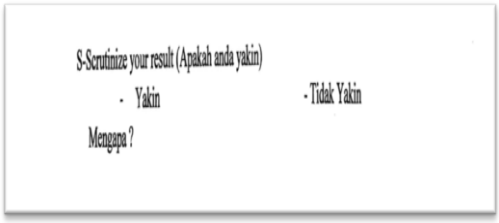

*E-Execute the solution (Apply the formula to solve the problem):*
*1 AC :850x6x30= 63.000*
*10lamp:20x20x10x30= 60.000*
*Magicom :80x2x30= 4.800*
*Pump : 100x2x300= 6.000*
*Iron : 300x1x30= 9.000*
*142.000* +

Figure 5 E-Execute the solution

In Figure 5 show that the application section of the formula to solve the problem, students have used the formula to find out how much power is used. However, students do not write down how the equation first. Students directly enter the numbers listed on the problem. In that answer, an error occurs where students do not change the unit into KWh form so that the student's answer does not match the existing answer key. This error can occur because students do not write the equation and its units completely so that it allows students to forget the units that should have been changed.

5. S–*Scrutinize your result* (Are you sure)

   The following examples of student answers on S–*Scrutinize your result* can be seen in Figure 6.




*S-Scrutinize your result (Are you sure)*
*- Sure - Not Sure*
*Why?*

Figure 6 *S-Scrutinize your result*

Based on the students' answers in Figure 6, it can be seen if students do not choose the choice of being sure or not sure of the answers they have written on the answer sheet of the previous problems solving criteria. Students are confused about writing answers that are sure or not sure because students themselves also do not know and understand what is being worked on.

The relationship between indicator of physics problems solving skill and average values can be seen in Figure 7.

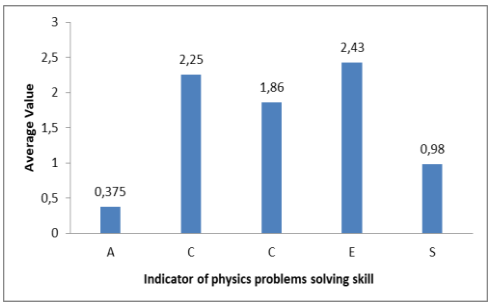



Figure 7 The relationship between indicator of physics problems solving skill and average values

From the Figure 7 of the relationship between indicators of physics problems solving skills with the average value obtained by students can be seen if, the lowest value is found on the indicator A (Assess the problem). Based on these values, it can be seen if students have not been able to identify what concepts are underlying these problems. However, the average student can answer correctly on the criteria C (Create a drawing) and E (Execute the solution). Here a misconception occurs where students do not know the concepts that underlie the problem, but students can write answers and formulas correctly. In criterion C (conceptualize the strategy), most students can describe the steps that will be used to solve a problem, but some of the students make mistakes due to the accuracy of student factors. Furthermore, the criteria S (Scrutinize your result) can be concluded if students do not have a sense of confidence in the answers they have made, most students are confident of the answers, but cannot mention the reasons why students believe in the answers students have made. Students cannot make excuses using related physics concepts. Some of the students also felt unsure of the answers made because the students forgot about the related material, and also the students had not learned before.

**Student Interview Questionnaire**

Based on the results of student interviews through questionnaires that have been distributed, it can be concluded if students have been taught about skills in problems solving. According to students, problem-solving is also very important to be taught so that it can be applied in everyday life. Almost all students do not know the steps in a scientific experiment, even only a few students have ever experimented. Experiments are not carried out in the laboratory but are carried out in the classroom. The experiment was very simple, by rubbing a ruler on the hair so that it could pull up sheets of paper that had been cut into small pieces.

For the size of senior high school, students, the experiment is no longer the realm. The experiment is more appropriate to be used by junior high school students. The reason for not doing the experiments in the laboratory is that the laboratory cannot be used properly. The laboratory is now being converted into a classroom for learning. Instead of not having an experiment in the lab, there should be other alternatives so that students find it easier to understand related concepts, for example, such as using a visual laboratory (PhET). However, according to the results of research conducted by none of the students who knew about the application of visual laboratories (PhET). After showing the visual laboratory application (PhET) by the researcher to students, it shows that students are interested in learning assisted by the PhET application.

**Teacher Interview**

Based on the results of interviews with the physics teacher concerned, they explained if problems solving skills are very important to be taught. In learning the most important thing is planting and understanding concepts. If concepts are well embedded in students, problems solving skills will be easily taught and accepted by students. Indirectly, the basis of successful problem solving is the cultivation of mature concepts. In teaching students to solve a problem, there are obstacles experienced by the teacher, namely the use of language when embedding concepts. The use of standard scientific language can make students confused so that the inculcation of concepts will be difficult to achieve. To overcome this, the teacher uses language that is not so standard and scientific, so that what the teacher conveys can be understood and accepted by students.

At school, when students do practical work, the teacher no longer teaches about scientific research methods. This is no longer done because, in class X, there is already the nature of physics material in which there are material scientific research methods. In the process of learning activities, to strengthen students' understanding, examples are often given in everyday life that is near them. So students are easier to understand the material that has been given by the teacher. In this school year (2019/2020 Academic Year), there has never been a practicum because the laboratory has been converted to function as a class. To better understand the material being taught, the teacher tries to introduce students to use a virtual laboratory application (PhET). According to observations made by the teacher, students are less interested in PhET-assisted learning. Because according to students, learning using virtual applications is not the same as learning that can be done using tools directly.

In the learning activities are undertaken by the teacher do not stick to the lesson plan that has been made. For example, in lesson plans, teachers use inquiry learning methods. However, when teaching in class, not only the inquiry method is used but also other

learning models (PBL / Conventional). This was done by following the ongoing conditions. The most important goal of learning can be achieved with a maximum.

The results of the analysis are presented to assess the effectiveness of the PhET-assisted learning model on problems solving skills possessed by students. The selected studies include research investigated in 2013, 2016, 2017, 2018 and 2019 as many as 10 (ten) studies. A summary of the analysis included in the systematic review can be seen in Table 1 below.

Table 1 Review of studies in 2013-2019

| Writer (Year) | Sample Characteristics | Research Design | Finding |
|---|---|---|---|
| Yusuf & Widyaningsih (2018) | N: class majoring in the education of physics and mathematics | • Using the Pre-Experimental Design type OneShot Case Study.<br>• To analyze SPS activities and student perceptions, an analysis technique was used to score them.<br>• Manipulation Variables: research sample.<br>• Control Variables: Research instruments, learning media, learning models.<br>• Response Variables: SPS and student perceptions | • The use of Virtual Laboratory media can develop SPS and student perceptions.<br>• Overall, SPS for students was 81.95% or in the very good category.<br>• Student perceptions of learning activities obtained an average of 78.53% ± SD 4.9, which fall into the category of strongly agree. |
| Rahmi, Zainuddin, & Suriasa (2013) | N: 30 | • The analysis used is descriptive analysis techniques qualitative and descriptive quantitative.<br>• Manipulation variable: learning model.<br>• Control Variables: research sample<br>• Response Variable: SPS | • The application of the learning model is considered efficient to increase student SPS as well as to improve student learning outcomes. |
| Widyaningsih & Yusuf (2018) | N: students who take courses Physics II Prodi Marine Sciences | • Research conducted includes descriptive research.<br>• The data analysis technique used in the form of data presentation in the frequency distribution table along with a histogram graph.<br>• Manipulation Variables: Learning media<br>• Control Variables: research sample, Student Worksheet<br>• Response Variable: student learning outcomes. | • The application of PhET simulations shows progress in learning outcomes<br>• Learning outcomes obtained by 62 ± SD 18, which fall into either category.<br>• Students feel happy learning using the PhET application |
| Hidayat, Hakim, & Lia (2019) | N: 2 class XI SCIENCE 22 Palembang High School | • The research uses quasi-experimental research. The research design used was matching the controlled post-test groups. M data | • The guided discovery learning model based on PhET simulation has a significant effect on students' understanding |

| Writer (Year) | Sample Characteristics | Research Design | Finding |
|---|---|---|---|
| | | analysis uses a t-test.<br>• Manipulation Variables: research sample (experimental class and control class)<br>• Control Variables: test instruments, learning methods, learning media.<br>• Response Variable: Understanding of physical concepts. | of physics concepts:<br>• t arithmetic > t table = 8.17> 1.67, which means $H_o$ is rejected. |
| Primadani et al., (2016) | N: class X students ($A_1$,$A_2$,$A_3$) | • The study design uses one group pretest and one group post-test.<br>• The method used to collect data is validation, tests, observations, and questionnaires<br>• The data analysis technique used is quantitative and qualitative descriptive analysis.<br>• Manipulation Variables: learning models<br>• Control Variable: research instrument<br>• Response Variable: problems solving skills | • Learning devices that are declared valid legibility student teaching materials and student worksheet included in the high category<br>• Problems solving skills possessed by students are getting better, which can be categorized in the high category<br>• Students' reactions to the learning model used positively |
| Kohar, Jatmiko, & Raharjo (2017) | N: three classes XI of Senior High School 4 Surabaya in the academic year 2015/2016 | • Research carried me wearing a single group pretest and post-test. Data collection techniques use observation, tests, and questionnaires.<br>• Data Analysis Techniques using descriptive qualitative and quantitative.<br>• Manipulation Variables: research instrument.<br>• Control Variables: research sample.<br>• Response Variables: student misconceptions. | • Validity:<br>• A lesson plan validation is good. Student Teaching Materials is good enough, Student Worksheet is good, Misconception is generally valid<br>• Average Student Teaching Materials readability of 59.8% and Student Worksheet of 71.3%.<br>• The average difficulty level of Student Teaching Materials is 32.5%, and Student Worksheet is 34.3%<br>• Practicality includes: Learning devices are classified in either category. The level of student activity is categorized as good |

| Writer (Year) | Sample Characteristics | Research Design | Finding |
|---|---|---|---|
| | | | • The effectiveness includes: Misconception test results with N (g) 0.73. The results of the analysis with statistical tests in line with ANOVA are: There were no significant differences in the decrease in misconceptions of the three classes. N-Gain decreases in students' misconceptions experienced in each class. Student responses to KBM are positive. |
| Anisah, Wati, & Mahardika (2016) | N: Grade VIIIA student of Junior High School 31 Banjarmasin | • This type of research meng use of research and development by adapting the development model of the camp.<br>• Manipulation Variables: research instrument<br>• Control Variables: learning models, research samples<br>• Response Variables: student learning outcomes | • The development of tools using structured inquiry is efficient for use and belongs to a good and feasible category. |
| Marlena, Sari, Yanti, & Walid (2019) | N: 16 | • Research using quantitative descriptive methods.<br>• Mechanical collecting data using questionnaires questionnaire structured questionnaire<br>• Control Variables: research samples, research instruments.<br>• Response Variables: science process skills | • Most students already have good science process skills.<br>• The lowest value of 30 (including low criteria), medium value 55 (including medium category) and the highest value is 95 (including high criteria) |
| Sari, Tjandrakirana, & Kuntjoro (2018) | N: 30 | • This research is pre-experimental<br>• The study design used a group pretest and post-test.<br>• The data analysis technique used is quantitative descriptive.<br>• Manipulation Variables: research instruments and learning methods.<br>• Control Variables: research sample<br>• Response Variables: process skills and knowledge aspects. | • The application of PhET simulation science can increase the level of students' skills and knowledge.<br>• The skills of the students increased as indicated by the average value of the post-test results 80 (N-gain; 0.71 with high criteria)<br>• The aspect of student knowledge increases with the average value of 80 post-test results (N-gain; |

| Writer (Year) | Sample Characteristics | Research Design | Finding |
|---|---|---|---|
| | | | 0.74 with high criteria)<br>• The frequency of activities conducting experiments / observing that is 18.3 percent while the activities that students do at least are behaviors that are not relevant to KBM by 3%<br>• Student responses to learning are (83% with very strong criteria) |
| Sari, Munasir, & Jatmiko (2018) | N: class XI-SCIENCE students (1,2,3) | • Data collection is done by observation. Engineering analysis Data clicking uses descriptive qualitative and quantitative descriptive.<br>• Manipulation Variables: the behaviour of each class<br>• Control Variable: observation instrument<br>• Response Variable: Problems Solving Skills | • The PhET-assisted PO2E2W learning model practically can be applied to the learning process to increase the student's Problems Solving Skills physics.<br>• The average value of two observers in class XI SCIENCE 1 is 3.30 in the good category with the percentage of agreement 96.75%, XI SCIENCE 2 is 3.71 in both with a percentage of agreement 95.84%, and in class XI SCIENCE 3 is 3, 76 in the excellent category with an approval percentage of 96.85%.<br>• Obstacles during learning activities can be overcome appropriately. |

Based on the above Table 1 can be concluded if the learning model that has never been taught to students can affect the problems solving skills possessed by students and science process skills. Learning media assisted by virtual laboratory applications (PhET) can help students to understand better the material being taught.

Structured inquiry-based science learning tools can increase scientific literacy in students (Hasanah, Jamaluddin, & Prayitno, 2019). The use of learning strategies using inquiry can improve critical thinking skills and conceptual understanding of students (Anggareni, Ristiati, & Widiyanti, 2013).

The use of virtual laboratories can help students to improve their skills in solving a problem (Sutarno, A., A., I., & Putri, 2017). The use of Mobile Pocket Book can support learning activities so that students have good problems solving skills (Noviatika, Gunawan, & Rokhmat, 2019). The level of understanding of concepts possessed by students can be increased using inquiry learning models with the help of a Virtual Laboratory (Kusdiastuti, Harjono, Sahidu, & Gunawan, 2016). Inquiry learning using simulation media can also improve

student learning outcomes (Hayati, Hikmawati, & Wahyudi, 2017). Problems solving skills and students' critical thinking skills can also be enhanced using the guided inquiry learning model with the help of the PhET application (Agustina, Sahidu, & Gunada, 2020). The structured inquiry learning model using the 5E learning cycle can improve learning outcomes and science process skills possessed by students (Hartati, Corebima, & Suwono, 2015). The structured inquiry learning model can also affect the improvement of critical thinking abilities and cognitive learning outcomes of students (Handriani, Harjono, & Doyan, 2015). Besides the learning model that uses the problems posing approach can also improve students' problem s solving abilities (Jannah, Doyan, & Harjono, 2015).

Based on the explanation above, there is a previous kind of research that has been done with the result that, the learning process using inquiry, especially using structured inquiry, has proven to be effective in students who have never used the learning model that was previously inquiry. With the help of a PhET application for subjects which practicum cannot hold, it helps students to understand the related material better. For example, in the matter of black body radiation, gas, atoms and the like. This has been tested with a variety of tests that have been carried out, both tests on students and tests or validation of learning devices that have been used. By using structured inquiry and PhET-assisted learning models students can solve problems better than before, students have a good scientific process and can understand the material much better than before using the method.

## CONCLUSION

Problems solving skills possessed by students can be classified into low and medium categories. Because of this, efforts are needed to improve problems solving skills in students. Efforts that can be made to enhance problems solving skills require learning models that have never been taught, namely by using structured inquiry learning models assisted by PhET.

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