Profile of Students' Problem Solving Skills and Implementation Inquiry Model in Senior High School

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Profile of Students' Problem Solving Skills and Implementation Inquiry Model in Senior High School

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Abstract

This study aims to determine the profile of students' problem-solving skills and the implementation of inquiry models in high school. This type of research conducted using preliminary research methods with data collection techniques in the form of written tests filled out by students, student interview questionnaires and teacher interview questionnaires. The data obtained were analyzed descriptively qualitatively. The study was conducted on 30 students of class XII Science 5 of Senior High School 1 Driyorejo. The results showed that only a few students used the strategy of problem-solving skills in solving Dynamic Electric problems. Of all students studied, there were 16 students had moderate category problem-solving skills and 14 students had low category problem-solving skills. The lowest problem-solving skills criteria are at point C (conceptualize the strategy). The implementation of the inquiry learning model which is not maximal causes students to not be active in class so that their problem-solving skills are low and there is no laboratory to support learning. Students are never invited to use a virtual laboratory (PhET) to support learning. So the need for alternative solutions to improve students' problem-solving skills by applying appropriate learning methods.
Keywords: **inquiry, PhET, problem-solving skills**

INTRODUCTION

The 21st century is century of knowledge, marked by the rapid development of technology. In the 21st century, information can be accessed quickly and the abundant availability of knowledge is very broad. The rapid development of technology has an impact on various fields such as socio-cultural, political, economic and educational that makes one country with other countries interrelated. From these fields, there is one thing that is most crucial in Indonesia, namely education, where the condition of education in Indonesia continues to experience changes. Over the last 20 years there has been a change in the education system in Indonesia, the change certainly leads to Information and Communication Technology (ICT) (Soderstrom, From, Lovqvist, & Tornquist, 2011).

To create good quality human resources, education in Indonesia needs to implement the 4 pillars of education as stated by UNESCO, namely; learning to how, learning to, learning to be, and learning to live together. The four pillars must be preserved in-class activities, to improve student skills. Besides, the world of education today needs a movement in a more advanced direction so that future generations can compete globally through the development of 21st-century learning competencies that require students to have knowledge and skills, especially in the field of technology.

The learning model in the 21st century is a student-centered learning model, where during the learning process students are required to be more active than the teacher. One effort to improve the quality of education in Indonesia is to improve the curriculum (Yazid & Suprapto, 2018). In Indonesia, the curriculum has been changed many times, the latest curriculum change is the

2013 curriculum. Whereas the 2013 curriculum that is currently applied has referred to a scientific approach, students are conditioned in an atmosphere of active learning to make students have a variety of skills, one of which is solving skills problem. Thus students will be easier to solve all problems because in daily learning activities at school have been taught problem-solving skills by the teacher. Because based on learning in schools aims to improve problem-solving skills in students (Gok, 2015), problem-solving skills are essentially the main things in learning (Bogard, Liu, & Chiang, 2013; Kim, 2012) where these skills have covered all cognitive aspects students (Chang, 2010). Various problems can be solved by the existence of these problem-solving skills (Sitika, Muharjito, & Diantoro, 2015) to get the best solution for the existing problems (Markawi, 2013).

According to Heuvelen (Wijayanto, 2011), the results of a survey conducted by the American Institute of Physics in the United States stated that the competencies most commonly used were competencies in problem-solving, teamwork, and communication. Another survey conducted by the Science and Technology Council in the UK said that the problem-solving skills used by most people to solve problems were around 30%. It can be observed that problem-solving skills are very important possessed by each student so that they can solve problems properly and appropriately because someday students become superior human resources and able to improve the nation's intellectual.

Fikat (2018) in his research stated that if problem-solving skills possessed by students were low, this was evidenced the low index of problem-solving. The problem-solving skills of students in Indonesia that are still low are also supported by research conducted at Senior High School 1 Driyorejo which shows that students at the school still have low levels of problem-solving skills, this is due to students not understanding the concept of the material especially if the material it is necessary to do a practicum. Students are never invited to do a practicum in the laboratory because the facilities to be used for practicum are inadequate, there is no laboratory at the school. So when given a problem, students are not allowed to find their way in solving problems but the teacher immediately provides answers to these problems as a result students are not skilled in solving a problem. Also, several factors cause students to have low problem-solving skills, including learning models used by teachers in teaching still using conventional learning models. Learning in the classroom is not fully active, only the teacher is active in learning, especially when studying physics. That is, learning physics has not been integrated with the development of science and technology and is dominated by teacher-centered learning (Fathiah, Kaniawati, & Utari, 2015). This is what causes the low problem-solving skills of students, students are not taught the stage of good problem-solving. Based on these data it is necessary to improve students' problem-solving skills through the application of inquiry learning models.

The inquiry learning model is a learning model that requires active students, so students can find their knowledge. According to Bruner (Trianto, 2011), Everyone learns to find knowledge so that the best results are obtained. With inquiry learning students will investigate existing problems. Through investigation, students will better understand the subject matter in depth.

According to Hamruni (2012: 95), The steps of using inquiry learning methods are: (1) orientation is the teacher makes the class more active, (2) formulates the problem, (3) proposes a provisional

conjecture, (4) collects data, (5) tests Hypothesis is the student tests his hypothesis based on data that has been collected. (6) Making conclusions, (7) applying conclusions where students use the conclusions obtained from the problem.

The application of the inquiry learning model is certainly very closely related to technology, wherein the era of the industrial revolution 4.0 the use of learning technology is a competency that must be possessed by professional teachers. The use of instructional media makes it easy for students to learn when applied with the help of technology will make it easier for students to remember lessons (Lia, 2015). Student interaction with the media can increase student involvemen to play an active role in improving problem-solving skills. The relationship between the inquiry learning model and technology is in finding data, of course, students do a practicum. Because the facilities at the school are inadequate, practicum can be done using existing technology. One application that supports learning is a virtual laboratory in the form of Physics Education Technology (PhET).

PhET is a irtual laboratory that can facilitate teachers and students in learning in the classroom. PhET simulation is a simulation that is easy to operate on its own, almost all of the physics material is in the PhET application that can be downloaded by students through the website http://phet.colorado.edu so that when not under supervision the student can still do the practicum while students have the application Phet. Students can do practical work with mobile phones or laptops that have PhET installed. Kusnadi (2013) said that the advantages of virtual laboratories are that students can use the application for their practicum to make students directly involved in learning and can hone their creativity, practicum conducted by PhET does not require a lot of time when repeating data and there are illustrations of the movement of an electron so students are more familiar with the material discussed.

To identify the level of problem-solvi skills of Driyorejo High School 1, it is based on NTEO and the Taxonomy of Introductory Physics Problems (TIPP) as well as by using the GW-ACCES protocol instructional strategy (Teodorescu, Bennhold, Feldman, & Medsker, 2013). The problem-solving step of ACCES consist of (1) A-assess the problem, (2) C-create a drawing, (3) C-conceptualize the strategy, (4) E-execute the solution, (5) S -scrutinize the result. In the first stage, students identify physical principles related to existing problems, so they know in what way the problem can be solved. In the second stage, students represent problems in the form of images to solve oblems. In the third stage, students describe the steps that will be used to solve problems so they can easily solve problems system ically. In the fourth stage, students apply the formula to solve the problem so they can get the right results by following the principles used and the formula applied in solving the problem. In the fifth stage, students write down the level of confidence in the answer, which is between sure and not sure along with the theory unde ying the answer.

The pur se of the research is to find out the profile of students' problem-solving skills and impl entation of inquiry in high school. Based on the description above, the researcher conducted a study entitled "Profile of students' problem-solving skills and implementation of inquiry in high school.

METHOD

The research used uses the type of search Preliminary Research and is descriptive and not to test a hypothesis.

The results of the study are used to find out appropriate learning models to be applied in improving problem-solving skills. This research was conducted in February 2020 of 30 students of class XII Science 5 of Senior High School 1 Driyorejo, Gresik. Data collection in this study was carried out by the interview method, the test method, and the questionnaire method given to students. To get the instrument data used are (1) teacher's interview sheet which contains the teacher's profile in teaching in class, (2) test questions sheet that contains three questions with dynamic electric material, (3) answer sheet that contains five steps of problem-solving (ACCES) to facilitate students in solving problems, and (4) student questionnaire sheets.

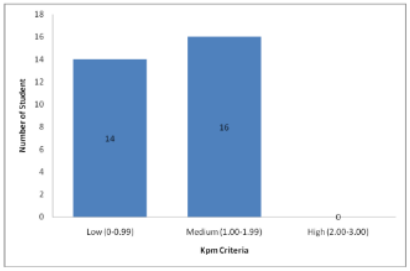
The data that has been obtained is analyzed using descriptive. The purpose of this analysis is to explain the learning conditions in the school through the results of the data obtained during the study. The results of the analysis will be presented in the form of graphic interpretation of the ability of students' problem-solving skills in working on problems divided into three categories, namely: (1) Low = If the value of problem-solving skills is less than 1. (2) Medium = If the value of problem-solving skills is more than equal to 1 and less than 2. (3) High = If the value of problem-solving skills is more than equal to 2 and less than 3.

RESULTS AND DISCUSSION

The results of this study aim to determine the physics problem-solving skills (Kpm), especially on Dynamic Electric material. The student test sheet consists of 3 questions that require the description of the answers. The answer sheets provided are equipped with indicators of problem-solving skills (A-C-C-E-S) and students are asked to enter their answers by following the indicators provided. Besides, students were given a questionnaire consisting of 4 questions about students' experiences while studying Physics at school.

1.1 Troubleshooting Skills Test on Dynamic Electric Material

Based on the data obtained, the value of the level of problem-solving skills is calculated based on respondents' answers. If the logical, complete, and systematic answer gets 3 points; if the answer only meets two elements (logical and complete or logical and systematic) get a value of 2; if the answer only meets one element only gets a value of 1; and if the answer is wrong (does not meet all three elements) get a value of 0.

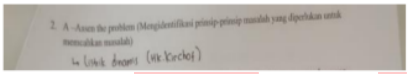


Graph 1. Graph Number of students on each Kpm criteria

Based on the assessment that has been carried out with the above criteria, the value of problem-solving skills is different between one student and another student. Some of them have moderate problem-solving skills and some are low, but there are no students who have high category problem-solving skills. There were 14 students in the low category and 16 students in the medium category. To determine the level of problem-solving skills students can be obtained based on student answers on the answer sheet that is equipped with Kpm criteria (A-C-C-E-S).

The results of problem-solving by one of the students can be presented in the picture below:

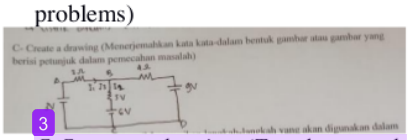
1. A-Assess the problem (identify the principles of the problem)



A-assess the problem (Identify the principles of the problem: find the voltage flowing at the point BC (V_{BC})

In the picture above, students are asked to present any principles related to the existing problem, containing a law and symbols that are in the material of dynamic electricity. However, based on the students' answers the students are not yet right in identifying problems, which only answers the law used to solve problems. To solve these problems students should use Kirchoff's Law I and Kirchoff's Law II and look for I_{BC} values.

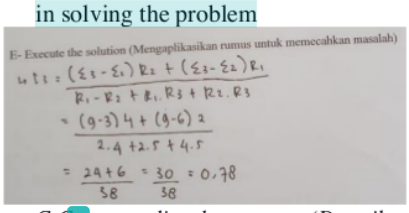
2. C-Create a drawing (translating words into drawing or drawing that contains instructions in solving problems)



C-Create a drawing (Translate words into pictures or drawings that contain instructions for solving problems)

In the picture above, students are asked to pour out their ideas that help in solving problems in the form of drawings, equipped with the current direction, the direction of the Loop, the symbols of a component and numbers by following the information obtained at the stage of identifying the principles of the problem. However, based on the students' answers, students in solving problems do not give directions to the right current direction and do not provide directions for Loop I and Loop II so that the circuit is difficult to understand and students cannot solve problems.

3. C-Conceptualize the strategy (outlining the steps that will be used in solving the problem



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

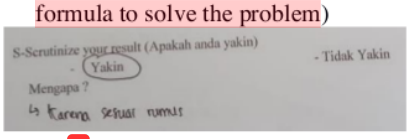
$$I_3 = \frac{(\Sigma_2 - \Sigma_1)R_2 + (\Sigma_3 - \Sigma_2)R_1}{R_1R_2 + R_1R_3 + R_2R_1}$$

$$I_3 = \frac{(9-3)4 + (9-6)2}{2.4 + 2.5 + 4.5}$$

$$I_3 = \frac{24+6}{38} = \frac{30}{38} = 0.78$$

In the picture above, students are asked to describe the steps to solve the problem. However, based on students' answer sheets, it is known that students do not describe the steps to solve problems, students only write the formulas that will be used to solve problems. The formula written on the answer sheet is wrong and does not fit the theory.

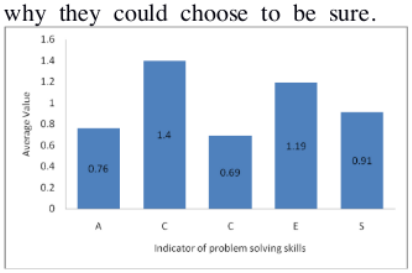
4. E-Execute the solution (apply the formula to solve the problem)



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

In the picture above, students express the level of confidence in the answer through writing along with theoretical reasons that support their choice. However, students based on the answer sheet above only chose to be sure they did not explain clearly

why they could choose to be sure.



Graph 2. Graph of the average value of students' problem-solving skills at each Kpm

From the graph above, the lowest value on the Kpm C indicator (conceptualize the strategy) students cannot describe the strategy properly to solve the problem. That is because students experience misconceptions that are indicated by the value obtained by students on Kpm A (Assess the problem), students do not understand the concepts related to the problems that have been presented sometimes some students only know the concept of the problem but do not understand. In Kpm C (Create a drawing) and E (Execute the solution) the average value of students is better than the other three Kpm, students can make drawings that contain instructions to solve problems such as giving the direction of the loop and the direction of the current in the circuit. While on Kpm S (Scrutinize the result) students do not explain why he chose the answer "sure" on the answer sheet that has been provided. Most students choose to believe but are not able to explain the theories that support their choices, this shows that students are not confident in answering. This low problem-solving skill is because students do not actively participate in learning, where the learning process is still teacher-centered. This is in line with the opinion of Sahyar & Fitri (2017) who say that students are less selective in solving problems due to teacher-centered learning. Learning can be done in groups to practice problem-solving skills in students (Hamdayama, 2016).

1.2 Student Questionnaire Results

A total of 30 students of class XII Science 5 at Senior High School 1 Driyorejo were asked to fill out a questionnaire regarding problem-solving skills, a total of 4 questions were asked in the questionnaire whose results were presented in Table 1.

Table 1. Learners' responses to the questions given in the questionnaire

Number	Question	Score	
		Ever	Never
1	Have problem-solving skills been trained by the teacher?	30	
2	Have you ever applied problem-solving skills in physics?	30	
3	Have you ever done experiments on "Dynamic Electricity"?		30
4	Have you ever experimented with a PhET virtual lab?		30

In Table 3, students' responses to problem-solving skills are shown that all students in one class have been trained in problem-solving skills by the teacher and apply them in physics learning. All students said that they had never conducted experiments or practicum in learning physics especially on Dynamic Electric material due to the unavailability of laboratory facilities in schools, and all students had never conducted experiments with virtual laboratories because they were never taught by the teacher. Therefore, even though problem-solving skills have been trained by the teacher but have never been applied directly (explained about the theory only), students also find it difficult to solve a problem. Teachers should look for other alternatives so that

students can practice, many alternative solutions can be used by teachers to support learning by utilizing virtual laboratory applications (PhET). Using the media to support learning makes students master the material well because it can be visualized and interactive (Syaifulloh & Jatmiko, 2014).

1.3 Results of Interviews with Teachers

The teacher interviewed was one of the Physics teachers at Senior High School 1 Driyorejo, the teacher said that problem-solving skills were very important to be trained on students. This is because to solve a problem well, it requires good problem-solving skills as well. During teaching, the teacher has practiced problem-solving skills to solve various problems or lesson problems. In this case, the students also responded quite well to what was taught by the teacher. Besides teachers have also applied inquiry learning models, where students are more active than teachers. However, as long as the teacher implements the inquiry learning model in the learning process the syntax applied by the teacher is not the same as the inquiry syntax, sometimes other learning models are also inserted because according to him it is difficult to match the syntax of the inquiry model. During teaching the teacher has never done practical activities, because there are no laboratory facilities at the school. Sometimes the teacher brings practical tools that are available in school and the teacher can only demonstrate in front of the class because the number of available tools is not possible to be used by all students. So students can only observe what the teacher is doing. The teacher also does not introduce virtual laboratories such as PhET to students as an alternative solution to the absence of laboratory facilities in schools.

1.4 Article Review

The results of the review are presented to explore the effect of inquiry models on student learning. A summary of the studies included in the systematic review with the inquiry model can be seen in Table 2. The study the researchers chose to investigate was between 2013 and 2019.

Table 2. Summary of studies included in a systematic review with the inquiry model

Author (year)	Sample Characteristics	Research design	Finding
Joko Setiawan, M. Royani [2013]	N: 31	Using a scoring technique using a checklist. To measure student learning activities used percentage analysis techniques. Manipulation variable: a learning model Control variable: number of students, learning material (build flat side space) Response variable: students' critical thinking skills	The application of inquiry learning can improve the effectiveness and critical thinking skills of junior high school students with a value of 79.49 with high qualifications.
Imelda, M. Arifuddin Jamal, dan Suyidno [2013]	N: 37	Using research development because in the research conducted in developing learning devices. Manipulation variable: a learning model Control variables: number of students, learning material (heat transfer), pictorial riddle method Response variable: the effectiveness of physics science learning tools through inquiry	The application of inquiry with the pictorial riddle method can improve student learning outcomes and critical thinking skills on the heat transfer material.

		learning models by the pictorial riddle method.	
B. K. Putri, A. Widiyat moko [2013]	N: 32	Using research and development models (Research and Development) Manipulation variable: student book (LKS) Control variable: number of students Response Variable: the effectiveness of Integrated Ipa LKS based on inquiry	Student books (LKS) developed effectively for use in learning.
R. Cahyani , N. Y. Rustama n M. Arifin, Y. Hendria ni [2014]	N: 28	*Research and Design (R&D) Manipulation variable: a learning model* *Control variables: number of students, Basic Natural Sciences courses* *Response variable: the ability of cognition, scientific work, and attitudes of Non-Natural Sciences students*	There is a significant difference in students' cognitive abilities between the scores of the pretest and posttest. Multimedia -assisted inquiry learning is quite capable of improving students' cognitive abilities (N Gain 0.31).
I. Akhlis, N. R. Dewi [2014]	N: 32	Using research development. Manipulation variable: learning device Control variable: number of students Response variable: student character	Scientific learning tools oriented on inquiry-based cultural deviation solutions using ICT can develop the character of learners providing a great opportunity to grow and develop these values.
Dwi Febri Setyoha di, Nurhida yati, Siska	N: 25	Using classroom action research design Manipulation variable: a	The inquiry learning model can increase student motivation

Desy Fatmary anti [2014]		learning model Control variable: number of students Response variable: motivation to learn	
Ida Bagus Rini Jayanti, Suyidno , Sri Hartini [2014]	N: 30	Using research design development Manipulation variable: a learning model Control variable: number of students Response variable: effectiveness of learning devices (LKS)	Learning devices developed are feasible for use by students in learning.
Nani Whuri Widarti [2015]	N: 39	Using qualitative research designs with descriptive research type Manipulation variable: learning model Control variable: number of students, learning material (social structure) Response variable: student learning outcomes	The inquiry learning model can be used to increase students' activities, interests and learning outcomes in sociology learning on social structure material in class XI IPS. After being given an action using the inquiry learning model the classical average value of 71.92%.
Wiji Riyadi, Ashari, Nurhida yati [2015]	N: 32	Samples were taken using a purposive sampling technique. Manipulation variable: a learning model Control	The application of inquiry learning models can create positive self-concepts and good physics

		variable: number of students Response variable: self-concept and physics learning outcomes	learning outcomes.
Nahdhiah Islamiyah [2019]	N: 24	Using a procedural model, namely: (1) identifying the problem, (2) identifying objectives, (3) designing and developing devices, (4) conducting tests, (5) evaluating test results, and (6) communicating test results. Manipulation variable: LKS Control variable: number of students, learning material (bacterial concepts) Response variable: the effectiveness of the learning device using the inquiry model	Development of learning tools on the concept of bacteria using the inquiry model in high school students produced valid, practical and effective.

Based on the table above it can be seen that inquiry learning can make students understand the lesson well, students have an unlimited range of knowledge through their exploration. In terms of cognitive and student skills, better than learning that does not use innovative learning models.

However, inquiry learning does not run optimally if it is not accompanied by the use of technology through virtual laboratories (PhET) to support learning because not all Physics material can be explained and described in real terms, for example, dynamic electric material and the kinetic theory of gas. In PhET applications material that in the real world cannot be seen in real terms can be seen properly. That way students can understand the material better, with the use of PhET can reduce the risk of errors in delivering information from the teacher and the knowledge that students own. And the data obtained is also guaranteed creativity because the conditions in the PhET application are ideal, without being influenced by the environment. Students also become more creative because they can arrange their experiments and can experiment with their ideas so that students' problem-solving abilities will also increase (Asyhar et al, 2017; Daesang et al, 2013; Yusuf, Subaer, 2013; Maesaroh et al, 2016; Mahyuddin et al., 2017; Debowska et al., 2013; Yusuf, Widyaningsih, 2018; Aziz, Yusuf, 2013; Hatimah et al, 2015; Mahanta, Sarma, 2012).

CONCLUSION

Based on the results and analysis found that the problem-solving skills of students at Senior High School 1 Driyorejo are in the low and medium categories. Based on tests of problem-solving skills with the A-C-C-E-S strategy and questionnaires that have been carried out by all students indicate that problem-solving skills need to be trained by the teacher and students need to be trained in problem-solving skills and be able to apply in physics especially in Dynamic Electric material. Students are never invited to do practical work because there are no laboratory facilities in the school and are never introduced to virtual laboratories (PhET) so students never use them. The effort that can be done by the teacher is by implementing a PhET-assisted inquiry model. So those students are expected to have good problem-solving skills with a Kpm value of students above 2 based on A-C-C-E-S.

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