Profile of Students’ Physics Problem-Solving Skills and the Implementation of Inquiry (Free, Guided, and Structured) Learning in Senior High School

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Abstract. Learning in schools has a significant role in improving 21st-century skills, including problem-solving skills. The objective of this research to determine the profile of students’ physics problem-solving skills and the implementation of inquiry (free, guided, and structured) learning in senior high school. The study was conducted on 84 students of state senior high school. This type of research was conducted using Descriptive Research Design (DRD). Data collection methods using tests, questionnaire, and interviews. The instrument of research used are (1) instrument tests of physics problem-solving skills, (2) response questionnaire sheets, (3) student and teacher interview sheets. The data obtained were analysed qualitatively descriptive. The results of this study show that only a few students can work on the material using problem-solving strategies of ACCES: (1) Assessing the problem, (2) Create a drawing, (3) Conceptualize the strategy, (4) Execute the solution, and (5) Scrutinize the result, in solving dynamic electricity problems. Implementation of inquiry (free, guided, and structured) learning provided is not ideal so that it causes students to be less active so that problem-solving skills are lacking and no laboratory supports the learning process. Students are not introduced to the existence of a virtual laboratory (i.e. PhET) as a laboratory replacement. So, to improve students’ physics problem-solving skills required proper inquiry (free, guided, and structured) learning assisted by PhET.

1. Introduction
In the era of the industrial revolution 4.0, it requires students to have 21st-century skills, including scientific creativity, critical thinking skills, scientific collaboration, new literacy, and problem-solving skills [1-15]. Learning in schools also has a significant role in improving 21st-century skills, including problem-solving skills. The results showed that learning in schools aims to improve students’ problem-solving skills [16-18], including physics problem-solving skills. If physics problem-solving skills are
not taught at the school level, students will have problems, namely not being able to compete in the 21st century and the era of the industrial revolution 4.0 [1,5,10].

Physics problem solving is an individual cognitive process to achieve the goals and solutions of physics problems at hand [19-25]. Teodorescu et al. [24-25] formulated problem-solving vulnerability indicators abbreviated as GW-ACCES, which include (1) Assessing the problem, (2) Create a drawing, (3) Conceptualize the strategy, (4) Execute the solution, and (5) Scrutinize the result. This indicator of problem-solving skills that researchers have explored in Indonesia has never been applied. Therefore, this study will use indicators of problem-solving skills in the form of Teodorescu et al. [24-25].

Learning that can improve learning outcomes includes problem-solving skills, one of which is Inquiry Learning [26-43]. Inquiry has advantages in learning, namely: (1) There is an increase in the ability of memory and understanding of learning material by students because the knowledge or information they get is based on their authentic learning experience when they (students) find their answers to questions that they also have. apply yourself during the learning process; (2) The inquiry learning model improves students' problem-solving skills in new and different situations that they may encounter at other times (in the future); (3) Inquiry learning model helps teachers simultaneously increase student motivation; (4) Students in the inquiry learning model will learn how to organize themselves to learn; (5) The basic concepts of a learning material will be remembered and deposited well in the memory of students; (6) encouraging indirectly to students to cooperate, be objective, honest, confident, full of responsibility, and share tasks [26-43].

The weaknesses of inquiry learning include: (1) When teachers and students are not yet used to implementing inquiry learning models, they often cannot manage time properly. (2) The teacher tells the information that the student should look for will cause the inquiry learning model not to function properly. (3) Students who are not accustomed to implementing inquiry learning can deviate from their original goal. (4) Students often gather information that is irrelevant and not so important. (5) Can reduce students' motivation to learn when students cannot find and complete assignments. (6) If there are too many students in the class, the teacher may find it difficult to facilitate the learning process of all students. (7) When inquiry learning is always set in groups, there are usually some students who are less active in the group [26-43]. Inquiry learning is divided into (1) Structured Inquiry; (2) Guided Inquiry; and (3) Free Inquiry [41].

The problem that has arisen in the last few years is the inadequate inclusion in teaching physics [26-27,29-30,31,33-39,42-43]. Based on the results of literature studies [26-27,29-30,31,33-39,42-43], no research specifically addresses the profile of students' physics problem-solving skills and the implementation of inquiry (free, guided, and structured) learning in senior high school. Therefore, this study will focus on obtaining truthful information from the profile of students' physics problem-solving skills and the implementation of inquiry (free, guided, and structured) learning in senior high school, specifically in physics learning. The novelty of this research is to bridge the results of previous research and facts in 2020 to obtain findings and recommendations related to the profile of students' physics problem-solving skills and the implementation of inquiry (free, guided, and structured) learning in one of the State Senior High School of Indonesia. From the findings and recommendations, it can be used as empirical evidence and further research can be carried out to produce improvements in the quality of education, especially relevant physics learning related to improving physics problem-solving skills.

2. Method

This type of research was conducted using Descriptive Research Design (DRD), but it also did not test the hypothesis [44]. The results of this study were to obtain truthful information from the profile of students' physics problem-solving skills and the implementation of inquiry (free, guided, and structured) learning in senior high school, specifically in physics learning. This research was conducted in February 2020. The subjects of this study were 84 students of State Senior High School 1 Driyorejo, Gresik, Indonesia. The technique of taking is using purposive sampling. Data collection methods using interview techniques, technical tests, and interview techniques. To get the instrument data used are (1) Instrumental Physics Problem Solving Skills Test, (2) Response Questionnaire Sheet, (3) Student and Teacher Interview Sheets. The research instrument has been validated by two experts and has been
declared valid and reliable. Indicators of physics problem-solving skills test include (1) Assessing the problem, (2) Create a drawing, (3) Conceptualize the strategy, (4) Execute the solution, and (5) Scrutinize the result [24-25]. Data analysis using qualitative descriptive. Criteria for students' physics problem solving skills (S) by the criteria of: (1) $S > 2.33$ (High); (2) $2.33 \geq S \geq 1.33$ (Moderate); and (3) $S < 1.33$ (Low).

3. Results and Discussion
This section will present the results of the research which consists of three main parts, namely (1) the results of the test of physics problem-solving skills, (2) the response questionnaire, (3) the results of the student and teacher interviews. The results of physics problem-solving skills are presented in Table 1.

### Table 1. Students' physics problem-solving skills.

| Indicators of physics problem-solving skills | Average score of students' physics problem-solving skills | Category of physics problem-solving skills |
|---------------------------------------------|--------------------------------------------------------|------------------------------------------|
| Assessing the problem                        | 0.74                                                   | Low                                      |
| Create a drawing                             | 1.99                                                   | Moderate                                 |
| Conceptualize the strategy                   | 1.47                                                   | Moderate                                 |
| Execute the solution                         | 1.73                                                   | Moderate                                 |
| Scrutinize the result                        | 0.60                                                   | Low                                      |
| Average                                      | 1.31                                                   | Low                                      |

Table 1 explains that students' physics problem-solving skills are classified as low. Average score of students' physics problem-solving skills in 1.31 (Low). These results indicate that the physics problem-solving skills of high school students are still in the low category. The findings of this study reinforce that problem-solving skills must be trained at the high school level by design. This statement is reinforced by the results of research which states that if physics problem-solving skills are not taught at the school level, students will have problems, namely not being able to compete in the 21st century and the era of the industrial revolution 4.0 [1,5,10]. To strengthen the research data in Table 1, the researcher conducted a qualitative descriptive analysis based on the results of the students' physics problem-solving skills written test as presented in Table 2.

### Table 2. The results of the written test of physics problem-solving skills by students.

| Indicators of Physics Problem-Solving Skills | Results of the Written Test of Physics Problem Solving Skills by Students |
|---------------------------------------------|-------------------------------------------------------------------------|
| A – Assess the problem (Identify the principles of the problem needed to solve the problem) | A-assess the problem (Identify the principles of the problem needed to solve the problem); find kWh all usage in 1 month |
| C – Create a drawing (Translate words in the form of pictures or drawings that have instructions in solving problems) | C-Create a drawing (Translate words in the form of pictures or drawings that have instructions in solving problems) |
| C – Conceptualize the strategy (outlines the steps that will be used in solving the problem) | C-Conceptualize the strategy (outlines the steps that will be used in solving the problem) |
| E – Execute the solution (Apply the formula to solve the problem) | E-Execute the solution (Apply the formula to solve the problem): |
Based on Figure 1 - Figure 5 shows that students are still not familiar with ACCES-based physics problem-solving. These results show evidence that physics problem-solving skills are very important to be trained immediately. The results showed that problem-solving skills are the main things in learning [45]. To strengthen the data on the results of the physics problem-solving skills test, the students' responses are presented in Table 2.

**Table 3. Students’ responses.**

| Question                                                                 | Ever | Never |
|--------------------------------------------------------------------------|------|-------|
| Have physics problem-solving skills been trained by the teacher?         | 83   | 1     |
| Have you ever applied physics problem-solving skills in physics?         | 84   | 0     |
| Have you ever done experiments on "Dynamic Electricity"?                 | 5    | 79    |
| Have you ever experimented with a PhET virtual lab?                      | 1    | 83    |

Based on Table 2, it shows that in general, physics problem-solving skills have been trained by design by the teacher. Besides, all students agreed that physics problem-solving skills were very important. However, the fact is that physics problem-solving skills are still low. It is a finding that there is a need for innovative learning models that are specifically developed and applied to improve physics problem-solving skills. It is strengthened by the results of research that various problems can be solved by the existence of these problem-solving skills [46-48] to get the best solution for the existing problems [49]. More deeply, an interesting fact has been found that most students have never experimented. Besides, many students have never used a virtual lab like PhET. Whereas the use of PhET can support visualized and interactive experiments [50].

The results of interviews with teachers and students at State Senior High School 1 Driyorejo include: (1) Students and teachers agree that physics problem-solving skills are very important in the learning process; (2) Teachers and students have often been involved in learning to improve physics problem-solving skills, but the test results show the fact that students' physics problem-solving skills are still low; (3) The teacher has also used guided and structured inquiry learning, but not for free inquiry. This is because free inquiry is still not applicable to students; (4) The syntax of the inquiry (structured, guided, and free) learning model used by the teacher is not standard, but has been modified according to the teacher's wishes; (5) Students have never been taught to use PhET, even though students want to use interactive media including PhET. However, this is in contrast to interviews with teachers who stated that students did not want to use PhET; (5) According to the students, in general, the teacher never invited students to intensively do inquiry activities (structured, guided, and free) in the laboratory, because in reality, the laboratory was not optimal; (6) According to the teacher, the implementation of inquiry learning is still very difficult to apply because there are so many materials in the curriculum and it will be time-consuming if inquiry-based learning is often used.

Based on the results of interviews with students and teachers, researchers formulated the profile of the implementation of inquiry (structured, guided, and free) in physics learning as follows: (1) the implementation of inquiry (structured, guided, and free) in physics learning has not been maximized to improve solving skills physics problems in high school. (2) The use of virtual labs to support inquiry learning in the form of PhET has also not been maximized. (3) Inquiry learning cannot be maximized if
students and teachers are not supported by real and virtual laboratories. This finding is reinforced by the results of research which found that learning physics has not been integrated with the development of science and technology and is dominated by teacher-centred learning [51].

4. Conclusion
In this study, it can be concluded that the profile of students 'physics problem-solving skills and the implementation of inquiry (free, guided, and structured) learning in senior high school as following: (1) students' physics problem-solving skills based on ACCES at State Senior High School 1 Driyorejo is still low; (2) indicators of physics problem-solving skills based on ACCES are still in the low category; (3) the implementation of inquiry (structured, guided, and free) in physics learning has not been maximally implemented to improve physics problem-solving skills in high schools; (4) The use of virtual labs to support inquiry learning in the form of PhET has not been maximized; (5) Inquiry learning cannot be maximized if students and teachers are not supported by real and virtual laboratories. This research implies that it can be used as an empirical basis that learning the implementation of inquiry (structured, guided, and free) in physics learning needs to be supported by both real and virtual laboratories. The limitation of this study is that it still uses 84 samples and state senior high school 1 Driyorejo, Gresik, Indonesia. Further research can be carried out to (1) increase the number of samples, the number of schools, and types of schools (public and private); (2) researching with a characterization of gender; (3) there is a need for improvement of physics problem-solving skills based on inquiry (structured, guided, and free) learning model with PhET.

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