Effect of application of dilemmatic problem solving oriented learning model in physics teaching on improvement decision making skills senior high school students

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Abstract. This aim of study is to obtain an overview of the improvement decision-making skill of senior high school students as the effect of applying dilemmatic problem solving oriented learning model in physics teaching. The research method used is pre-experiment with one group pretest-posttest design. The subjects of the study were 38 students in one of the high schools in West Bandung district. The subjects were chosen by random sampling technique. Instruments used for decision-making skill data collection at before and after learning is a test of decision-making skills in the form of essay test. The improvement of decision-making skills of high school students was analyzed using the concept of normalized average gain scores, <g> formulated by Hake. The results showed that 58% of students reach a high gain, 29% of students reach a moderate gain and 13% reach a low gain in decision-making skills. This shows that the use of dilemmatic problem solving-oriented learning model in Physics learning has a moderate effectiveness in facilitating the improvement of decision-making skill of high school students.

1. Introduction
One of the competencies that must be achieved by high school students after following Physics learning is high-order thinking skills (HOTS). One element in HOTS is the decision-making skill. This skill is very important in the 21st century because in this century the problems facing humans increasingly complex and dilemmatic. To solve this characteristic problem requires many high-level thinking skills such as critical thinking skills, creative thinking skills and decision-making skills [1]. This skill is classified as transferable skill that is a skill that can be built in the context of learning in school where it can be applied in facing the problems faced in the context of daily life [2].

Unfortunately based on the observation of the learning process in the classroom held in one high school in West Bandung district shows that the learning activities undertaken have not been oriented to training decision-making skills. Physics learning still tends to be oriented to the mastery of subject matter. The learning process is still implemented in a conventional, teacher-centered manner. Learning is verbal and informational. Such learning cannot be relied upon to provide students with decision-making skills, because in the process it does not facilitate students to practice decision-making activities. Soobard & Rannikmae stated that learning that does not train students in decision making will cause
students' decision-making skills to be low [3]. Further observation results indicate that the average of decision-making skills of students in that school is still categorized as low. One suitable learning model used for training decision-making skills is a problem solving-oriented learning model. Decision-making is usually done when a person is faced with a problem. Wood states that problem-solving and decision-making are two interrelated matters, in which problem solving often requires decision-making skills [4]. Correspondingly Dunca states that in problem solving there is the decision-making process [5]. According to Basyaib that decision-making is generally associated with the five steps in problem solving [6]. Thus, problem-oriented learning is seen as capable of providing decision-making skills as it facilitates students to be involved in decision-making.

However, not every problem must be solved through the decision-making process. Decision-making skills are usually needed when faced with dilemmatic issues. The issue of dilemma is a matter of choice where in every option there are advantages and disadvantages, making it difficult to make a choice. Because the problem to be addressed in problem-oriented learning is a dilemmatic problem. Setting collaborative activities is needed to facilitate interaction among fellow students in decision making so that students can use the opinions or thoughts of other students in making decisions. Collaborative is a group activity where students in groups are encouraged to interact and learn together. Barkley, Swartz and Tekbiyik stated that the problem given as a decision-making task should be done collaboratively. Discussion activities in collaborative groups can train students' critical thinking skills [7,8,9]. Critical thinking skills are needed in the process of problem solving and decision making. McMurtry & Humphrey states that combining decision-making and problem-solving with critical thinking leads to great ideas and solutions [10]. Critical thinking is a process involved in decision making [11,12].

On the basis of the above exposure, in the experimental study conducted to get a picture of the influence of the use of dilemmatic problem solving oriented learning model collaboratively on improving the problem solving skill of high school students. This paper describes the process and the results of experimental research applying dilemmatic problem solving oriented learning model

2. Method
The method used in this research is the pre-experiment method with the one group pretest-posttest design. Participants in this study comprised of 38 students (12 boys and 16 girls) at one senior high school in West Bandung district. The sample was chosen randomly. The experimental treatment used in this study is a dilemmatic problem solving oriented learning model (DPSOLM) that has the process stages as shown in table 1.

| Syntax of Model | Learning Activity                                      |
|-----------------|--------------------------------------------------------|
| Phase-1         | Cultivation of conceptual understanding uses inquiry approach |
| Phase-2         | The presentation of dilemmatic problem                  |
| Phase-3         | The introduction of decision-making strategies in solving dilemmatic problems |
| Phase-4         | Exercise to make collaborative decision-making to solve dilemmatic problems |
| Phase-5         | The presentation of results of dilemmatic problem solving |
| Phase-6         | Reflection and follow-up                                 |

To evaluate students' decision making related to kinetic gas theory (KGT) content as effect of applying a dilemmatic problem-solving oriented learning model, a Decision Making Related KGT Test (DMKGT Test) consisting of five items was developed in the form of an essay test. For the scoring of DMKGT Test results the scoring guidelines are used as follows: score 2 is awarded if the decision is taken correctly and the reasons put forward are logical; a score of 1 is awarded if the decision is taken correctly
but the reasoning is illogical, a score of 0 is given if the decision is taken incorrectly and the reasoning is illogical. Thus the maximum score for each question is 2 while the minimum score is 0.

The improvement of decision-making skills achieved by students is determined by using the concept of normalized gain averages, \( \langle g \rangle \), formulated by Hake as follows: [13]

\[
\langle g \rangle = \frac{\langle S_{post} \rangle - \langle S_{pre} \rangle}{S_{mid} - \langle S_{pre} \rangle}
\] (1)

Where \( \langle g \rangle \) is the normalized gain average, \( \langle S_{post} \rangle \) is the average posttest, \( \langle S_{pre} \rangle \) is the pretest average and the \( S_{mid} \) is the ideal ideal maximum score.

Table 2 shows the categories of average normalized gain to interpret the average normalized gain score of the decision making skill obtained from the calculations.

| \( \langle g \rangle \) | Category of decision making skills improvement |
|------------------|---------------------------------------------|
| 0.70 < \( \langle g \rangle \) < 1.00 | High                                     |
| 0.30 < \( \langle g \rangle \) < 0.70   | Moderate                                  |
| \( \langle g \rangle \) < 0.30       | Low                                       |

The effectiveness of the application of dilemmatic problem solving-oriented learning model in improving decision-making skills is determined based on the number of students who reach high gain decision making skill by using the guideline as shown in table 3.

| Quantity of students (R) reaching high gain of decision making skills (%) | Category of effectiveness |
|---------------------------------------------------------------------------|---------------------------|
| 75 < R ≤ 100                                                             | High                      |
| 50 < R ≤ 75                                                              | Moderate                   |
| R ≤ 50                                                                   | Low                        |

3. Result and discussion

3.1. Result

Figure 1 shows the bar chart of pretest score, posttest score and normalized gain score average of decision-making skill achieved by high school students as effect of applying dilemmatic problem-solving oriented learning model related to gas kinetic theory content.
From figure 1 it appears that the application of dilemmatic problem solving-oriented learning model in the study of gas kinetic theory can improve the decision making skills of senior high school students with moderate gain category. This is indicated by the average of normalized gain of 0.62.

Figure 2 shows a bar chart of the percentage of the number of students in each gain category of decision-making skills. It appears that the application of dilemmatic problem solving oriented learning model the study of gas kinetic theory has effectiveness in the medium category in improving decision-making skills of senior high school students. This is indicated by the percentage of students who achieved a high gain in decision-making skills by 58%.

![Bar chart showing percentage of students in each gain category](image)

**Figure 2.** Bar charts the percentage of the number of students in each gain category of decision-making skills.

3.2. Discussion

Achievement the average of normalized gain of decision-making skill and the number of students achieving gain decision-making skills in the high category as described in the results section shows that the application of the dilemmatic problem solving-oriented learning model has a good enough potential in train high school students' decision-making skills. This can be understood because in this learning there are stages of cultivation understanding of concept and training critical thinking skills that are needed in the decision-making process, namely the stage of cultivation understanding the concept with inquiry approach. According to Wening, learning using inquiry approaches has the potential to provide a complete understanding and can promote critical and creative thinking skills for students [14].

Critical thinking is a thought process involved in decision making. According to Johnson critical thinking is all mental activity that helps in making decisions [11]. While Swartz state that critical thinking is the process of thinking that is involved in decision making [8]. Some of the critical thinking roles in decision making: (1) assist in identifying problems encountered; (2) assist in collecting relevant information; (3) assist in analyzing problem-solving alternatives to determine the best option; and (4) assist in evaluating decisions already taken.

Collaborative settings in problem solving-oriented learning model also support the training of students' critical thinking skills. According to Wening the discussion and brainstorming activities between students can collaboratively train the critical thinking skills [14]. In collaborative work, students can give each other views and considerations for decision making, can mutually criticize the opinions of friends, and can reinforce opinions with friends. This is the way to form students' critical thinking skills.

The presentation of dilemmatic problems is strongly supportive of decision-making skills training. Students' habits use the stages of decision making in solving dilemmatic problems introduced in the learning process will be a good habit in solving the problems they face in real life in daily life.
4. Conclusion
The use of collaboratively dilemmatic problem solving–oriented learning model in physics teaching has effectiveness in the moderate category in improving senior high school decision making skill related to kinetic gas theory content.

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