Evaluation of physics learning on momentum and impulse topic of the senior high school students

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Abstract. This research aims to evaluate physics learning on Momentum and Impulse topic of the senior high school students. Learning evaluation was held toward students’ science processing skill, knowledge and competency, and skill of presenting a product. Learning evaluation was conducted on material momentum and impulse to the tenth year students of senior high school. This was a quantitative research by applying post-test only group design. Students’ science processing skill was measured by using students’ worksheet. The indicators consisted of observing, classifying, predicting, formulating hypothesis, designing investigation, and conducting experiment. Competence of knowledge was measured through multiple choice tests. Skill of presenting product was measured by applying performance assessment rubric. The data were analysed by using Rasch Model data analysis technique. The result of the research showed that; (1) the students’ science processing skill was categorized as skilful from the highest to the lowest found in the activity of predicting, formulating hypothesis, conducting experiment, classifying, and observation. Students’ achievement on the activity of designing investigation was categorized skilful and intermediate. (2) The students’ average achievement of knowledge competency was categorized medium, (3) the average achievement of the students in presenting product was categorized low.

1. Introduction
Physics as a subject in the school is a branch of the natural sciences that can explain each natural phenomenon in daily life [1]. Evaluation of physics learning is important to analyze the achievement of each learning goal. Physics learning is evaluated covering three main aspects namely aspects of the learning process, aspects of knowledge and aspects of skills. Students cannot do physics learning well without mastering good process skills. Science process skills are defined as tools to obtain information and also identify problems, formulate hypotheses about problems, make valid predictions, identify and define variables, design experiments to test hypotheses [2]. Science process skills become basic skills in understanding physics. The skill aspect can be a process approach that paves the way for students to understand the subject matter more broadly and deeply. Science process skills are needed to create and use scientific information, conduct scientific research, and to solve problems [3]. Science process skills are one of the major goals to be achieved in science education because these skills are utilized not only by scientists but also by everyone, in order to become scientifically literate people[4-5].

Evaluation of the physics learning process through physics science process skills is very important. Evaluating of KPS using test instruments [6-7]. This study will evaluate students’ Science Process skills based on student activities during the learning process. Student activities will be guided using
student activity sheets that have KPS indicators. Staged assessment of student activities using the student KPS assessment rubric during the learning process. Previous studies have conducted KPS evaluation data analysis using inferential statistics with the help of SPSS software, score addition, [6–9], t-test correlation tests [10], and analysis of covariance [11]. Evaluation of KPS in this study uses the Rasch model with the help of Winstep software. The achievement of students' science process skills has a relationship to improving students' knowledge and skills [12]. The science process skills that will be evaluated in this study are observation, classification, prediction, preparing hypotheses, planning experiments, and conducting experiments. Science process skills are a form of skill that can enhance students' physics knowledge.

The aspects of student knowledge that will be evaluated in this study are students' understanding of the concepts of momentum and impulse. Learning physics on the topic of momentum and impulses, students have been evaluated for understanding concepts, misconceptions, and implementing strategies [13–16]. This research will be conducted to evaluate the effect of science process skills on students' knowledge on the topic of momentum and impulse. The purpose of this study is to evaluate physics learning using science process skills, students' knowledge of material momentum and impulses, and student skills in presenting products.

2. Methods

The researcher used the case study approach with a post-test only group research design [17]. The research was conducted at one of the private high schools in Bandung City. The researcher used a purposive sampling technique to determine the research sample from students divided into 19 classrooms. The samples of the research taken were the tenth year students consisting of 22 students. The researcher used some instruments namely multiple-choice tests, students' answer sheets, and performance assessment rubric. Students are given multiple-choice tests at the end of learning hour which is used to evaluate the students' knowledge on momentum and impulse materials. Students' answer sheets were used to evaluate the science processing skill activity during the learning process. A performance assessment rubric was used to evaluate the students' basic competence in the form of skill to present a product. The science processing skill test was analyzed by using Rasch Model where the software used was winstep software to identify the validity, reliability, and complexity of multiple-choice tests.

![Figure 1. Validity Result using Rasch Model](image)

The multiple-choice test had 70.3% validity where the test items can be categorized valid. Besides validity, the multiple-choice test had 92 item reliability by using Rasch Model and 62% person reliability. Based on the data shown, the students' answer consistency can be categorized as low/weak. The quality of the test items in the instrument reliability aspect can be categorized as very good. The alpha Cronbach value to measure the reliability to measure the interaction between person and test items in overall gained 0.60. The alpha value showed that the test reliability is generally categorized medium.

The measurement column showed that the logit value for each item is sequenced. The logit value of test item number 8 was 4.19 logit indicating itself as the most difficult test item, while test item number 1 is the easiest which was -5.76 logit. The outlier or misfit test items with the data Outfit Mean Square (MNSQ) value gained was 0.5 < MNSQ < 1.5 [18]. Based on the data analysis result, the
MNSQ value of test item number 1 and number 7 was minimum measure, 1.79 and 2.59. Therefore, those three items must be revised or omitted.

3. Result and Discussion
3.1 Science Process Skills
The science process skill evaluated in this case study was limited to basic skills such as observing, classifying, predicting, formulating a hypothesis, designing investigation and conducting an experiment. Those skills are part of the approach used by the teachers in the learning process. The teacher used students’ answer sheets as media to help students to practice and to evaluate their science process skills. The teacher guides students to join the learning process based on the phase of KPS presented in the students’ answer sheets. Students’ answer sheet is also equipped with questions can be used to evaluate parts of science processing skill. After the learning process, the data of the students’ science process skill gained as shown in figure 2.

![Figure 2. Assessment of Students’ Science Processing Skill](image)

Based on the data gained as shown in Figure 2, the students’ basic science process skill can be categorized as very skillful (4), skillful (3), rather skillful (2). The students’ skill in observing, 12 students were rather skillful, 7 students were skillful and 3 students were very skillful. Those achievements can be categorized as good similar to the achievements found by other researchers on KPS. In the study, the achievement of indicators of observing with a percentage of 63.80 % (good) [8]. Observation activity started with a demonstration carried out by one of the students while other students are asked to observe. The observation results written by the students had not been able to describe contextual phenomena overall. In this phase, the teacher should provide direction questions on the students’ answer sheet to help them exploring information towards their observations.

In the skill of classifying, 8 students were rather skillful, 7 students were skillful and 7 other students were very skillful. Based on the students’ distribution of each category, there were still limitations faced in the learning process to develop the skill of classifying. Overall, the students’ achievement in this skill was categorized medium. Other research showed that the students got a score of 66.93 % in skill of classifying (categorized well) [10]. These two findings showed results with a slight difference. Therefore, in this phase, extra treatment is needed to help students classifying a variable.

In the skill of predicting, 7 students were skillful and 15 students were very skillful. The learning process in this phase is effective to develop students’ skill in predicting. The category percentage of very skillful was 67 % and skillful was 37 %. Another research also found that students’ skill was categorized well that there were 67 % of students categorized very skillful and 37 % of students categorized as skillful. Another research also found that students’ achievement was categorized well, including 62, 50 % of students [8]. The students’ success in this phase was supported by information gained from the previous phase of treatment. Students’ experience is directed to the observation and classification activity helps students to predict a phenomenon. Besides, the achievement of the
students was also affected by guiding questions written by the teacher on their answer sheet (LKPD). The use of LKPD can help teacher to analyze every observation result. The achievement in this skill is almost the same with skill of formulating hypothesis. Formulating hypothesis skill is gained from 8 skillful students and 14 very skillful students. These data signify that learning by using the science process skill approach is effective and successful.

In the skill of designing research, 11 students were rather skillful and the other 11 students were skillful. In the achievement of this skill, there were no students categorized as very skillful. Based on the data, the learning process conducted was effective, but there were some limitations still to be fixed. Some students tended to reinvestigate as they did in observation. However, there were two groups of students designing methods of investigation which is different observation. This indicated that learning can also provide a chance for the students to develop and practice their creativity.

The students’ achievement on experimenting skill was found that 11 students were categorized as very skillful and the other 11 students were skillful. The achievement percentage of students was 50 % categorized as skillful and other 50 % categorized as very skillful. Based on the data presented, the use of the science process skill approach in the learning process was effective. The activity of conducting an experiment was done well based on research design. Overall, the activity ran concussively and enthusiastically by the students. Previous learning was really helpful to understand the purpose and the procedures of the experiment. Another field study found that science process skill based on the experiment indicator was categorized low [2]. It is caused by students who are not familiar with the activity of science process skills in Physics learning [19].

Overall, the science process skill approach implemented can develop the students’ basic science process skills. However, there were indicators of science process skill which are not optimal yet. The use of students’ answer sheets in implementing the science process skill approach still needs improvement. Students’ responses written on the answer sheet tend to be unsystematically and not structurally provided. Report writing tends to be unstructured as in the segment of experimenting, designing research, drawing and concluding. It is better for the teachers to combine lesson plan consisting of presenting training ability to equip the students’ science process skills.

3.2. Knowledge Competence
Students’ competence of knowledge is evaluated based on the multiple-choice test score. The students’ score distribution is shown in Figure 3.

![Figure 3. Diagram of Multiple-Choice Score](image)

Students’ competence of knowledge is evaluated based on the multiple test score. The students’ score distribution is shown in Figure 3. Multiple choice test was compiled based on indicators to evaluate the achievement of knowledge competence. The evaluation was designed based on the category of memorizing (C1), comprehending (C2), implementing (C3), analyzing (C4), and evaluating (C5), as well as creating (C6) [20]. However, this research was only limited to category 1 to category 5. The mean score of the students’ knowledge competence based on the test result was 59. Overall, the learning approach has weaknesses in how to develop students’ knowledge competence. Based on Figure 3, there were four test items difficult for students to answer. The test item number 5 and item number 9 was correctly answered only by five students, while the test item number 8 and 10
correctly answered only by two students. The test item number 1 to number 4 can be correctly answered by most students. The aspects of student knowledge in the category of analyzing and evaluating are still low parts, in other studies on knowledge at the level of analyzing students is at the lowest level of knowledge [1]. Another weakness is the time allocation which is limited for students to complete the test. Moreover, the learning process needs to provide a test completion simulation.

3.3. Skill Competence
Students’ skill evaluated consisted of product assessment in case of presenting data. The instrument used was the performance assessment rubric. Dimensions evaluated consisted of (K1) presenting experiment procedures (K2) presenting tools and materials used in the experiment (K3) presenting experiment data, and (K4) presenting the conclusion drawn from the experiment the data gained on product assessment are shown in Figure 4.

![Figure 4. Diagram of product assessment](image)

Skill K1 gained was 66 % or 15 students with predicate 3 (skillful), 17 % or 4 students with predicate 2 (rather skillful) and 17 % or 3 students with predicate 0 (not skillful). Skill K2 gained was 34 % or 7 students with predicate 2 (rather skillful), 50 % or 12 students with predicate 1 (less skillful) and 17 % or 3 students with predicate 0 (not skillful). Skill K3 gained was 33 % or 7 students with predicate 2 (rather skillful), 50 % or 12 students with predicate 1 (less skillful) and 17 % or 3 students with predicate 0 (not skillful). Skill K4 gained was 83 % or 19 students with predicate 1 (less skillful), 17 % or 4 students with predicate 0 (not skillful).

Based on the data presented above, students’ skill in presenting the product was still low. Students are only skillful in presenting experiment procedures while in other skills they are still low. The learning implementation cannot effectively develop the students’ skill in presenting an experiment conclusion equipped with a literature study. The learning process implemented cannot develop students’ skill in all aspects of product presentation. The students’ limitations, in this case, can also be caused by the limited learning sources and learning approach. Other than that, the science processing skill approach needs to be provided to the students so they can habitualize themselves in presenting the scientific products.

4. Conclusion
Based on the result of the research, it can be concluded that the students’ science processing skill is categorized as skillful from the highest to the lowest such as predicting, formulating hypothesis, conducting an experiment, classifying, and observing. The students’ achievement in designing research was only categorized as skilful and rather skilful. The average of the students’ achievement on knowledge competence was 59 (categorized as rather skilful). The average achievement of the students in presenting products was categorized as skillful only in K1 indicator.
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