

## **Development of worksheet based on high-order thinking skills to improve high-order thinking skills of the students**

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**Abstract.** This research aimed to develop high order thinking skills worksheet in momentum, impulse, and collision topic for senior high school. This type of research is Research and Development follow 4D models, includes : define, design, develop and disseminate. Data collection instruments used validation sheets for given to 5 validator, Aspects assessed include graphic, presentation, language, and the contents of worksheet. Based on the result of data analysis showed that all aspects got average score in the range of 3.4 to 4 with categories of very high. Thus, high order thinking skills was valid. For the purposes of testing the worksheet is given on 68 students. to measure the effectiveness of worksheet used Higher Level Thinking Ability Test that amounts to 12 items. Based on the result of data analysis indicate, There is difference of higher order thinking skill of students who use HOTS worksheet than who are not use HOTS worksheet, where the average Higher Order Thinking Skill on students who use HOTS worksheet higher

**Keywords:** *Higher Order Thinking Skills, Worksheet, Momentum, impulse and collision.*

### **1. Introduction**

Today, economic and technological developments are growing rapidly. Economic and technological developments alter the future shape that today's students must face. Schools should start planting high-order thinking skills (HOTS) to meet the demands of the 21st century (Basuki, 2014).

Higher-order thinking is the level of thinking at a higher level in the cognitive hierarchy. according to Quermalz (1887) higher order thinking skills are 5 forms of reasoning: Recall, analysis, comparison inference and evaluation. In addition, according to a review in philosophy, HOTS occurs when a person gets new information and information stored in memory is interconnected, reorganized and extends this information to reach the goal

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or find possible answers in confusing situations (Ricland and Simms, 2015).

But in reality, most schools do not teach students to think critically or solve complex problems. Textbooks contain facts that require students to remember only, thus, most of the students' ability evaluation tests are limited to memorizing the facts (Zohar and Dori, 2003). The ability to think this level of remembering based on Bloom's taxonomy is still classified into low-order thinking or called Lower Order Thinking (Anderson & Krathwohl, 2001). Therefore, there needs to be a change to a higher level called HOTS

Correspondingly, in the field of science especially physics usually considered difficult and not attractive to most students. This happens because students are only exposed to materials with formulas and equations that turn out students are still less able to apply and analyze it. This is indicated in one of the results of research by Rufaida (2012), the results of data analysis of the study obtained still many mistakes made by students in solving the given problem related to the material momentum, impulse and collision, which is one of the material of physics which is important to understand because of its many applications in everyday life. The results of the study were 36% of misconceptions, 84% misinterpretation, 68% concept error and 60% miscalculation.

To fix these problems requires the efforts of various parties, especially the educators themselves. An educator is a subject dealing directly with students as an educational object that plays an important role in developing the potential and thinking skills of students. According Chinedu, C.C. & Kamin, Y. (2015). teachers can do a lot to encourage higher-order thinking. Creative innovations for the realization of educational goals should be made.

According Taufik (2009) to run innovations in educational institutions, educators must also be innovative. Teachers need to make innovations that support the development of HOTS in the teaching and learning process. Starting from the methods of learning techniques, media, and teaching materials that can also other things that support. Student's teaching materials are made a choice because of the advantages in developing the ability of students to learn about the fact and capable of general principles and abstract using realistic arguments (Lismawati, 2010; Gusmida, 2017). So, it is expected from this HOTS worksheet can train student punishment in analysis, comparison, inferens and evaluation with HOTS indicator according to Quelmalz (Taghreed & Fakhri, 2014)

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## 2. Methodology

The type of research used is research and development or Research through 4 stages of the 4D model covering the stages of define, design and develop. In the define stage, the needs analysis revealed the needs of teachers and students related to learning problems and teaching materials available. In addition, the analysis of students, materials, tasks and formulate goals so as not to deviate from the purpose of developing teaching materials. After the define stage is done the design phase includes media selection activities and the selection of formats that apply to the material analysis and formulation of goals that have been set. Last is the stage of develop is a stage that aims to produce worksheet. Development activities are carried out by design validation performed by team of experts. Various data and inputs obtained from this validator serve as a revision material so that rmenghasilkan HOTS worksheet valid.

The instrument used in this research is worksheet validation sheet used to obtain data about the assessment of the validator. Aspects assessed include aspects of chart and presentation, language, and content. Aspect assessment using Likert scale. Furthermore, trials of HOTS worksheet use were conducted on 68 students using the High Level Thinking Ability Test instrument, which amounted to 12 items. The data obtained are compared between the control and experimental classes to then be concluded whether the worksheet is effectively used to improve the ability of high-level thinking.

## 3. Results and Discussion

The first stage in the development of HOTS worksheet is done by means of pre-research needs analysis to know the problem the need of development of teaching materials. From this analysis it was found that out of 50 students, 64% have HOTS in the low category. Furthermore, the analysis of student characteristics, in this analysis process found three general characteristics of students who will use the product of this development ie 1) students aged 16-17 years at senior high school students , which at this age individuals have the ability to coordinate both simultaneously and sequentially two kinds of cognitive abilities, the ability to use the hypothesis and the ability to use the principles abstract (Ustad MJ, 2012). 2) the questionnaire results show that of the 29 HOTS indicators observed through a front-end analysis questionnaire, 13 indicators are in the low category. 3) the students' skills in the classroom are very heterogeneous. According to Nana Sudjana (2007) there are at least 6 individual differences that exist in the students such as intellectual development, language skills, experiential background, learning style, talents and interests and personality.

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After knowing the basic problems in school and characteristics of students , conducted a study of curriculum, syllabus and concept-concepts of the material that will be taught to summarize the purpose of learning. The education standard process mentioned that the objectives of the study provide clues to select the subject content, organize the sequence of topics, allocate time, choosing teaching aids and teaching procedures, and provide a standard measure to measure student achievement

Then the next step is media selection. At this stage the media used are worksheet teaching materials which are refers of high-level thinking skills. The mometum, impulse and collision materials are composed of 16 hours of lessons, which divided into five worksheet. worksheet 1 discusses the momentum of the sub-section, worksheet 2 discusses the impulse sub-section, worksheet 3 discusses the law of conservation of momenum, worksheet 4 discusses the collision sub-chapter and worksheet 5 related to simple rocket modification experiment

Worksheet is designed with full color display that contains two activities. The first activity is the discovery of a concept called a guide to thinking. This activity is designed to construct concepts on students' cognitive structure. While the second activity is an activity applying physics concept. In this activity students apply concepts that have been found in previous activities. Each step in this activity is integrated with HOTS indicators.

The last stage of this research is the validation stage of product. In the first stage of validation, the validator provides suggestions for improvement. Suggestions from validators are used to repair HOTS. Worksheets Improved results given back to the validator for reassessment. After correction, the validator gives an assessment on the validation sheet which consists of aspects graphical, representation of worksheet, language and content of worksheet.

The results of validation of aspects of graphical and representation of worksheet related to the display, writing and illustration as well as language aspects which include the use of sentences and language used are summarized in Table 1 in the presentation aspect

Table 1. Results of Worksheet Validation

No	Aspects of the Validated	Mean	Category	Conclusion
1	graphical	3,45	Very high	Valid
2	presentation	3,8	Very high	Valid
3	Language	3,47	Very high	Valid

Table 1 shows that the results of worksheet validation on the aspect of graphical get an average score of 3.45. In this aspect the validator performs

an assessment of the design, layout and drawings/illustrations. This shows that worksheet already has an interesting design, well-written and readable text and drawings/illustrations that fit the concept. Based on the creative guidance to create innovative teaching materials (Andi Prastowo, 2011) one of the aspects that need to be considered in developing worksheet for the rich benefit is determining the design of worksheet development. Starting from the display, paper size, page density, numbering and clarity of writing should be considered as well as possible. Furthermore, the validator also conducts an assessment of the content aspect consisting of 10 indicators that contained in Table 2

Table 2. Results of Aspects of Contents of Contents Worksheet

No	Aspects Validated	Mean	Category	Conclusion
1	Material conformity with curriculum	3,6	Very high	Valid
2	The depth of the student's level of thinking	3,4	Very high	Valid
3	Encouraging students concept, law or fact	3,6	Very high	Valid
4	Analyze	4	Very high	Valid
5	Comparison	3,6	Very high	Valid
6	Inference	4	Very high	Valid
7	Evaluation	3,6	Very high	Valid
8	Systematic concepts	3,6	Very high	Valid
9	The relationship of concept with daily life	3,8	Very high	Valid

After a valid worksheet is obtained, then this whorksheets is tested in a group of senior high school students. The result is a high-order thinking ability of students who used HOTS whorksheets higher than students who do not use HOTS worksheets., this can be seen in Figure 1.

### Analysis

Analysis is a form of reasoning in understanding the relationship between the whole with its component parts and between cause and effect. In this level of reasoning, it also includes activities of sorting, categorizing, working methods, understanding causal relationships, and obtaining information from charts, diagrams or maps (Jennifer lyn, 2013). The question for this indicator of analysis requires high-level thinking and critical but not repeat the knowledge learned. Operational verbs are often used are why, how to use, how things work, give examples. Referring to the description of the analysis then developed the steps of activities and questions in accordance with the demands of the indicator. Each question is presented with illustrations and or drawings that will assist students in reasoning.

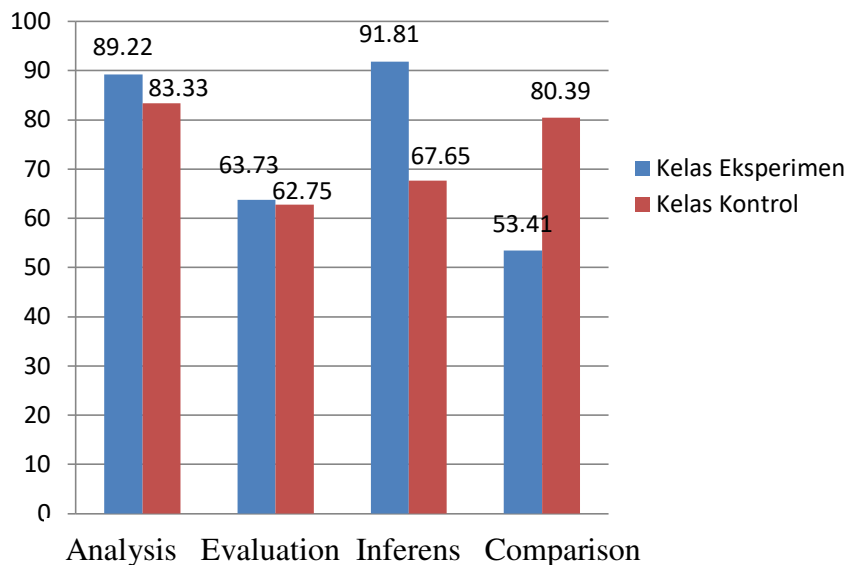


Figure 1. Higher Student Thinking Ability of each Indicator

The following will be discussed one by one each HOTS indicator , that is

In Figure 1, the average score of each indicator of higher-order thinking shows better results through learning using HOTS worksheet. compared with conventional learning. From the data it has been seen that learning using HOTS worksheet. can be applied to train higher order thinking skill students. This difference is due to the use of HOTS worksheet, students are accustomed to reasoning in understanding the relationship between the whole with the component parts and between cause and effect. Within this level of reasoning, it includes sorting, categorizing, understanding how to work, understanding causal relationships, and obtaining information from charts, diagrams or maps (Jennifer lyn, 2013).

### Comparison

At this level students are expected to explain how things are the same or different. Comparing between two things, simple or complicated. A simple comparison is based on some of the more obvious properties. While complex comparisons require extensive testing of a number of characteristics between two or more things to be compared. The comparison begins with the whole / part of which is related to the category of analysis and brings it to the next stage (Gregory, 2005). Improved high-order thinking skills by using HOTS whorksheets because through this worksheet students are familiarized with explaining how something is the same or different. more obvious traits, phenomena occurring in everyday life. According to Bagrut (2012) the Comparison indicator is "Comparing is to find similarities and contrasts to draw conclusions."

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## **Inference**

At this level contains the ability to explain inductively or deductively. In a deductive duty, students give the reasons from general to specific and are asked to recognize and explain evidence or facts. While on an inductive assignment, students are given evidence or details and are asked to link and integrate information into a common form (Stiggins and Conklin, 1992). The special features of this indicator are operational verbs used such as predicting, hypothesizing, reasoning, concluding, and solving. Based on data assessment results of this indicator is in very high category with average 4. This data indicates that this indicator is valid. This indicates that the issues given in the HOTS workheet provide an improvement on the ability to infer / conclude the students in the experimental class. This is because the students used HOTS workheet get used to predict, hypothesis, give reasons, conclude, and solve problems that occur in everyday life. Attract and evaluate conclusions. This process involves the ability to relate the conclusions to the underlying evidence or to the underlying conclusions. This ability can be assessed by providing an explanation of an inquiry and conclusion resulting from the investigation and conclusion, then asking which conclusions or alternatives which conclusions correspond to the evidence obtained on the investigation (Bahrul H and Yusuf S, 2010).

## **Evaluation**

At this cognitive level, students will be able to express and defend opinions. Assessment assignments require students to consider quality, credibility, pricing and practicality using the established criteria and explain the criteria to be appropriate or not (Moseley, et al., 2005). For example, students are asked to provide an assessment of the solution by determining the best solution to a problem, ensuring the value of its effectiveness or benefits.

The result of the validity test of this evaluation indicator is 3.6 in very high category. So, it can be concluded that the evaluation indicator is valid. Through this indicator students are expected to be trained in providing opinions, assessments, and the best solution of the problems faced or presented.

Based on the results listed in the Figure 1, can be seen experimental class given treatment in the form of HOTS workheet get more results on Evaluation indicator. Anderson and Krathwohl (2010) define evaluation is making judgments based on criteria and standards by examination and criticism. At this cognitive level, students will be able to express and defend opinions. Assessment assignments require students to consider quality, credibility, pricing and practicality using the established criteria and explain the criteria to be appropriate or not (Moseley et al., 2005). Based on Bloom's Taxonomy (in Anisah Firdaus, 2013) is the highest level of thinking in the cognitive domain of Bloom's taxonomy. Assessment here is

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the ability to make judgments about a condition, for example if a person is faced with several choices then he will be able to choose the best option in accordance with the standards or criteria that exist. For example, students are asked to provide assessments and solutions by determining the best solution to a problem, ensuring the value of its effectiveness or benefits.

#### 4. Conclusion

Based on the results of research, data analysis and discussion it can be concluded that the development of HOTS worksheet, has been through the validation process and stated valid in terms of content and constructs. Validation results from the expert team review include the eligibility of the format, language and content judged to be valid. The use of HOTS based worksheets can improve students' higher-order thinking skills.

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