

## Development of Science Worksheet Oriented on Marzano's Taxonomy to Improve High Order Thinking of Elementary School Students

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### Keywords

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Thinking Skills  
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Worksheet  
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### Abstract

Higher order thinking skills are defined as the broad use of the mind to find new challenges. These higher thinking skills want him to apply new information or prior knowledge and utilize the information for possible answers in new situations. higher thinking skills include: Analyzing (C4), Evaluating (C5), and creativity (6). Based on the observations, it is known that teachers have never developed HOTS-based worksheets, teachers only provide learning tools in the form of paper worksheets, where students answer the questions based on what they know. So that learning and use of the WORKSHEET are perceived to have flaws, such as students not completing the questions provided. This study aims to find out how to develop HOTS-based worksheets in science learning. The data collection techniques were carried out using validation techniques to meet the needs of material experts, design experts, linguists and practitioners. The results of the study were: have developed HOTS-based worksheets in science learning. Based on the findings, it can be concluded that the HOTS-based WORKSHEET in science education is recognized as valid and does not require a significant reworking, making it ideal for use as instructional materials.

### Introduction

According to Valentine, thinking in psychological studies explicitly examines the process and maintenance for an activity that contains "how" which is connected with ideas that are directed towards some expected goal (Safitri, 2019). The thought process is inseparable from human activities, the results obtained from the thinking process can be in the form of ideas or ideas that can be useful for themselves and others. One's thinking ability can be trained, one way to train thinking skills is by learning science. The thinking process is closely related to the cognitive domain where in its realm there are aspects related to intellectual and thought processes (Rizki et al., 2022). In Marzano's taxonomy the cognitive system is divided into 4 levels, namely: level 1 Knowledge Retrieval, level 2 Understanding (Comprehension), level 3 Analyzing (Analysis), level 4 Knowledge Utilization. Basically, there are two levels of human way of thinking, namely low-order thinking and high-order thinking. According to the World Economic Forum, there are three main abilities for workers in 2030, namely higher cognitive, social and emotional, and technological. Higher cognitive abilities can also be said to be high-level abilities, because these needs high-level abilities need to be improved so that workers can compete (Sunyono et al., 2019).

Robert J. Marzano identified 13 categories of High Order Thinking Skill (HOTS) levels, namely: Comparing, Classifying, Inductive Reasoning, Deductive Reasoning, Analyzing Errors, Constructing Support, Analyzing Perspective, Abstracting, Decision Making, Investigation, Problem Solving, Experimental Inquiry and invention. These categories belong to levels 3 and 4 of the cognitive system of Marzano's taxonomy. However, students' high order mathematical thinking skills are still low.

In Marzano's Taxonomy there are 6 levels of cognitive domains developed, namely: (1) Level 1 Knowledge Retrieval/Recall, (2) Level 2 Understanding, (3) Level 3 Analysis, (4) Level 4 Knowledge Utilization, (5) Level 5 Metacognition, (6) Level 6 Independent Thinking System. At level 1 students will carefully identify statements relating to information recognition, reproducing the required information, and executing/carrying out a mental process or physical procedure. At level 2 students will identify critical or important elements of knowledge, and describe critical aspects of knowledge in the form of pictures or symbols. At level 3 students will be able to identify similarities and differences, identify superordinate and subordinate categories derived from information, identify fixation of logical or factual errors in knowledge, conclude a new formulation/generalization from known knowledge, and make and maintain predictions about what is known. occur. At level 4, students will conclude a new formulation/generalization from known knowledge, fulfill objectives accompanied by obstacles, generate and test a hypothesis by conducting experiments and collecting data, as well as generating a hypothesis and using assertive statements and opinions from others to test the hypothesis.

At the next level of Marzano's taxonomy, namely level 5, students will set goals related to information, students will be able to monitor the progress of achieving certain goals, students will be able to determine the extent to which he has clarity, and will be able to determine the extent to which he is accurate about information. At level 6, which is the highest level in this cognitive domain, students will be able to identify how important information is, identify beliefs about their ability to improve competence, identify their emotional responses to information, and will be able to identify the overall level of motivation to increase competence or relative understanding.

The results of the 2018 PISA (Program for International Students Assessment Program) initiated by The Organization for Economic Co-operation and Development (OECD) reported that Indonesian students' mathematical abilities were ranked 73 out of 78 countries with an average score of 379 (OECD, 2018a). When compared with the international average score of 489, this result is quite far behind. PISA contains six levels of mathematical ability. At levels 4, 5, and 6, there are tests whose indicators are similar to the HOTS ability indicators in Marzano's taxonomy including selecting, comparing, and evaluating appropriate problem-solving strategies (Gustika, 2020). In addition, students can conceptualize, generalize and use information based on investigations and modeling of complex problem situations. The results of the 2018 PISA test, show that based on the Percentage of students at each proficiency level in mathematics, the percentage of Indonesian students' mathematical thinking at level 3 is around 7%, level 4 is about 3%, level 5 is around 3%. less than 1% while at level 6 no one is able to reach that level (Gustika, 2020). This shows that the high-level thinking ability of Indonesian students in science is still relatively low. Marzano develops a more detailed understanding of the process of learning and thinking. The thinking skills model developed by Marzano combines a wide range of factors that influence how students think, and presents research-based theories to help teachers improve their

students' thinking skills (Fortuna, 2018). The ability to analyze is one indicator of the ability of High Order Thinking in Bloom's Taxonomy and Marzano's Taxonomy. In addition to the low thinking ability of students, the results of interviews prove that teachers lack innovation in creating learning both in the learning model and teaching materials used by students, some summaries of the results of interviews conducted by Fortuna (2018) are as follows: (1) students' interest in learning mathematics is still low. fairly low; (2) the learning method used by the teacher is still limited; (3) the practice questions used still use books that are routine questions and have not used the type of questions with HOMT; (4) learning is still not fully student-centered; (5) more students who scored below the KKM than those who were above the KKM; (6) the manufacture of teaching materials is less innovative.

The results of interviews with elementary school science teachers show that teachers rely on textbooks that the government gives them without being able to add their own ideas. Worksheets are still bought from a publisher, so they only have questions that are similar to the example, which does not help students in higher-order mathematical thinking. To solve the above problems, scientists are trying to make learning tools that meet the requirements of the 2013 curriculum. They do this by using a learning model that is based on scientific steps and a work process that meets scientific criteria. Scientists also put a lot of emphasis on inductive reasoning. which examines a particular phenomenon or circumstance in order to make general conclusions. The Warli research, which found that reflective students tend to solve geometric problems more carefully than impulsive students, suggests that the reflective inquiry learning model may be able to improve students' thinking skills. Reflective students are very careful when solving problems, paying attention to aspects, so the answers obtained tend to be few but accurate.

## Method

This research was conducted using the Design Based Research (DBR) method. The subjects used in the study were 5th grade elementary school students and 5th grade teachers. The data were obtained using a questionnaire from 20 student respondents who were random sampling and interviews with 5th grade teachers. The questionnaire used was an answer questionnaire containing 5 questions. Interviews with classroom teachers contain questions about the development of worksheets which will then be analyzed descriptively to be used as reference material for discussion. Questions on student questionnaires are presented in Table 1 while interview guidelines for teachers are presented in Table 2.

**Table 1: Student Needs Analysis Questionnaire**

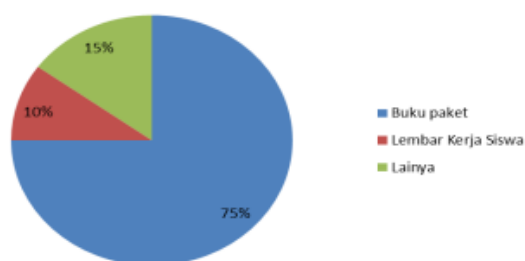
Question	Student Responses
Is science lesson difficult?	Yes
Do you need teaching materials other than what your teacher gave you?	Yes
Does the teacher's method use the lecture method?	Yes
Do you understand the science material that has been explained by the teacher?	Yes
Do you understand learning media such as worksheets?	Yes

**Table 2 : Teacher Needs Analysis Questionnaire**

Question	Teacher Response
Are you sure that all students understand the material that has been presented?	No
Do you use the lecture method when explaining?	Yes
Are you using the media when you explain?	No
Do you need to use worksheet?	Yes
Do you need worksheets that have been developed?	Yes

## Results and Discussion

Student responses to the needs of learning resources for each question as shown in table 1 are presented in Figures 1 to 3 below:



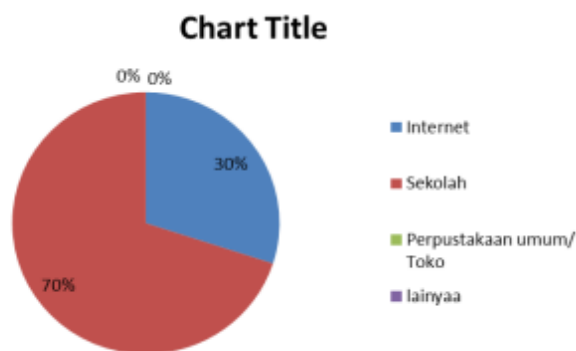
**Figure 1. Learning resources used by students in learning**

Based on the results presented in Figure 1, of the 20 respondents who answered a questionnaire on the use of learning resources in science materials, 75% used textbooks, 10% used worksheets, and 15% used other sources other than those mentioned above.

Learning resources are very important for a teacher. Learning resources include anything that can be used to assist a teacher in learning, teaching and displaying competence. Various learning resources around students' lives have not been used optimally in learning. Most teachers tend to use textbooks as the only source of learning. There are still many teachers in Indonesia who use textbooks as the only benchmark in teaching. In fact, there are many learning resources other than books that are very effective in increasing students' understanding such as the surrounding environment, libraries, objects and so on (Nur, 2012).

From Figure 1, it can be seen that 75% of learning resources in science materials still use textbooks. This shows that the learning resources used by students are not varied. The use of worksheets and other learning resources is only 15%. Science lessons are very fixated on textbooks and do not provide opportunities for students to study nature directly, causing students' knowledge to be fragmented. Students consider science lessons are lessons that only apply at school and only come from books.

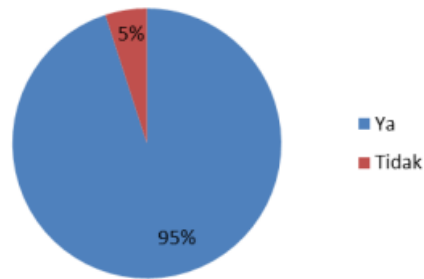
One of the printed teaching materials that can be used in learning is a worksheet. Worksheets are printed teaching materials that can help students in the learning process. Worksheet is one of the means to assist and facilitate teaching and learning activities so that an effective interaction will be formed between students and teachers, so as to increase student activity in improving learning achievement (Ranti & Usmeldi, 2019). Worksheets are sheets containing assignments done by students that contain instructions and steps to complete the tasks given by the teacher. The use of worksheets in learning has benefits in improving students' process skills, developing scientific attitudes, and fostering student interest in learning (Amalia, et al., 2014). It can be said that worksheets are teaching materials in the form of sheets that can be used to develop students' skills and knowledge in the teaching and learning process (Ramadhani et al., 2021).



**Figure 2. Diagram of where students get learning resources**

Based on the results presented in Figure 2, of the 20 respondents who answered the question about where students get learning resources from, the majority of students get learning resources from schools. Out of the 20 students who answered school, as much as 70% and 30% of students get learning resources from the internet. However, none of the students get learning resources from public libraries/bookstores.

In addition to using books from schools as teaching materials, students also get learning resources from the internet. The use of learning resources from the internet is very common in this century. This is supported by an increase in digital communication which is currently very easily accessible for all people. However, apart from learning resources from books and the internet, learning resources obtained from nature are also very influential. The lack of use of nature as a learning resource is one of the causes of the limited ability of students to apply the knowledge gained at school in everyday life.



**Figure 3. Diagram of students' perceptions of the learning resources used**

Based on the results presented in Figure 3, of the 20 respondents 95% of the students answered that they understood the concepts presented by the teacher in the science material and 5% of the students did not understand the science concepts.

Based on the results presented in Figure 6, from the answers of 20 respondents 80% of students answered the summary of the material, 10% of students answered textbooks and 10% of other students chose the type of worksheet learning resource. The results of interviews from classroom teachers who were used as interview sources for each question as listed in Table 2 are presented in the following description. Teachers use learning resources in the form of textbooks, using the lecture method, LKPD. In teaching and learning activities for science subjects the teacher has never used the module as a learning resource. However, the learning resources used by teachers are in accordance with the basic competencies to be achieved and can assist students in achieving learning outcomes. The development of modules/worksheets has never been done by teachers, so in this case the development of modules equipped with practical activities needs to be done to make it easier for students to understand science concepts.

From the results of interviews from 3 elementary schools that were conducted during the preliminary study, the teacher assumed that worksheets were learning tools in the form of sheets to check students' knowledge in understanding the material that had been studied. Teachers are used to using worksheets in learning according to the material learned in learning, but so far teachers are not accustomed to making their own worksheets to be used in learning. In using worksheets in learning, teachers are accustomed to using worksheets that have been made by publishers and at the same time integrate with practice questions. Teachers have not been trained to make and develop their own worksheets which are used as guidelines or directions for students in carrying out the learning process. The worksheet used is not the result of the teacher. Teachers are accustomed to using worksheets that have been made by publishers. The worksheets that are commonly used usually contain a number of materials and exercises from the material that has been studied. In terms of its constituent components, the worksheet used is still not composed of the components that should be in the worksheet. The components that are often overlooked in the development of the worksheet above are; student identity; questions that help students to make inferences and a conclusion column.

## Conclusion

The results of a preliminary study conducted by researchers in Grade 5 Elementary Schools found that the use of worksheets in elementary schools had not been developed to its full potential. The teacher assumes that the worksheet is a set of questions to evaluate students' knowledge of the material that has been studied. Worksheets are usually presented in conjunction with study guidebooks and exercises published by publishers to train students' abilities. The worksheets containing work instructions are rarely developed and are usually only used in practical activities and teachers are still less able to develop them themselves. The components that must exist in a worksheet have not been fulfilled optimally. Thinking skills that are often developed in learning in elementary schools are still around the stages of knowing, understanding and applying (low order thinking skills), while the ability to analyze, evaluate and create (high order thinking skills) is not developed optimally.

## Recommendation

Based on the results of research and discussion, the authors put forward some suggestions as follows:

1. The development of the Marzano High Order Thinking Skill Taxonomy-oriented worksheet is the beginning for the development of the Marzano High Order Thinking Skill Taxonomy-oriented worksheet, it is hoped that there will be other research to develop the Marzano HOTS Taxonomy-oriented worksheet in other learning.
2. This research and development were carried out to produce Marzano HOTS Taxonomy-oriented worksheets, it is hoped that there will be further research that examines the effect of using Marzano HOTS Taxonomy-oriented worksheets on student learning outcomes.

## Acknowledgements or Notes

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