P-ISSN: 1693-1246
E-ISSN: 2355-3812
June 2023

Jurnal Pendidikan Fisika Indonesia 19 (1) (2023) 47-54
DOI: 10.15294/jpfi.v19i1.34259

http://journal.unnes.ac.id/nju/index.php/jpfi

An Analysis of Students' Higher Order Thinking Skills Through the Project-Based Learning Model on Science Subject

K. Khaeruddin[1]*, S. Indarwati[2], S. Sukmawati[2], H. Hasriana[1], F. Afifah[1]

[1]Universitas Negeri Makassar, Indonesia
[2]SMPN Negeri 33 Makassar, Indonesia
*Corresponding author: khaeruddin@unm.ac.id

Received: 02 January 2022. Accepted: 02 February 2023. Published: 10 June 2023

Abstract

The learning and assessment process that is oriented towards Higher Order Thinking Skills (HOTS) is a very urgent task for teachers in schools today. But in practice, the teacher cannot suddenly give an assessment with the HOTS system if the teacher has never been familiar with the HOTS-oriented learning model in the daily learning process. Teachers must carefully design HOTS-based learning and assessment, starting from the preparation, implementation, and evaluation stages based on the revised 2013 Curriculum. The project-based learning model is a learning model that is able to facilitate students in solving problems and higher-order thinking processes. Therefore, the focus of this research is to describe students' higher order thinking skills through a project-based learning model in science subjects at SMPN 33 Makassar. This study used a pre-experimental study with a One-Group Pretest-Posttest design. The sample in this study were 114 students at the junior high school level. The results showed that there was an increase in students' HOTS test scores from the pretest, posttest stage one and posttest stage two. This shows that the project-based learning model contributes to increasing the HOTS of SMPN 33 Makassar students in science subjects. Especially in the aspect of Physics.

Keywords: Analysis, Thinking skills, Project

INTRODUCTION

The current implementation of the 2013 Curriculum has undergone revisions to content standards and assessment standards. The content standard stimulates students to be able to think critically and analytically in accordance with international standards by deepening and expanding material that is suitable for students. In the assessment standard, gradually adapting the international standard assessment model, which focuses more on Higher Order Thinking Skills (HOTS) (Cai,& Sankaran, 2015; Hammond, & Falk, 2013; Haniah,& Setiawan, 2020). But in practice, the implementation of the assessment standard by emphasizing the HOTS received other complaints from students regarding the questions given during the National Examination in April 2018 for the High School (SMA) and Madrasah Aliyah (MA) levels that there were weighted questions who have a level of difficulty that requires high reasoning power (Astra, Raihanati, & Mujayanah, 2020; Paidi, Mercuriani, & Subali, 2020; Siburian, & Pangaribuan, 2020). Muhadjir Effendy stated that the weight of the questions in the implementation of the National Examination had begun to apply international standards, both for questions of Natural Science, literacy and Mathematics requiring high reasoning power or HOTS (Hartik, Utaminingsih, & Madjdi, 2021; Rahmadani, 2019). Based on the results of the Program for International Student Assessment (PISA) and Trends in International Match and Science Survey (TIMSS) surveys, since their participation in 1999, the ranking of Indonesian students has not been able to occupy the top position (Deratama, Wulan, Diana, & Agustian, 2022; OECD, 2013; Summaries, 2019). The two surveys show that the majority of students in Indonesia are still at the Lower Order Thinking Skills (LOTS) level. After the issue of the need to develop HOTS items, education observers "challenged" and doubted the policy. They considered that the HOTS questions developed by the teacher were impossible for students to answer

considered that the HOTS questions developed by the teacher were impossible for students to answer if the learning process in the classroom was still conventional and students had never been trained to solve the HOTS questions developed by the teacher (Prince, & Felder, 2016). Kristiyono (2018) adds that the importance of HOTS learning and assessment for now, therefore teachers must immediately try to organize HOTS learning in schools. However, in practice, teachers cannot suddenly give an assessment using the HOTS system, if in the daily learning process they never get used to the HOTS-oriented learning model (Doppelt, 2015). Teachers must carefully design HOTS learning and assessment, from the preparation, implementation, and evaluation stages that have been designed based on the revised 2013 Curriculum.

The approach suggested in the 2013 Curriculum was not easy to do, because there are many factors that influence it, namely the characteristics of subjects and or subject matter that are not entirely effective when using a scientific approach, time constraints, and limited learning media. In addition, it was also found that in the field there were many teachers who still had difficulties in implementing HOTS-oriented learning. According to Fanani, & Kusmaharti (2018) states that this can be seen in the formulation of indicators, objectives, learning activities, and assessments in the learning designs made and the implementation of the learning process. Teachers must be able to develop and then convert learning from LOTS to HOTS, and this must have been started since designing the Learning Implementation Plan (LIP).

Sani (2019) explained that higher order thinking skills are defined as information stored in our memory and obtaining new information, then connecting, compiling, and developing existing information in order to achieve a goal or obtain answers in confusing situations. The transformation itself makes students able to analyze, synthesize or combine facts and ideas, generalize, explain, arrive at a conclusion or interpretation. Manipulating information and ideas through this process will make it easier for students to solve problems, gain understanding, and find new meanings. Furthermore, Arikunto (2014) also states that there are eight aspects associated with higher order thinking. They are no one can think perfectly or can't think all the time; remembering something is not the same as thinking about that thing; remembering something can be done without understanding it; thinking can be embodied in words and pictures; there are three types of intelligence and thinking, namely analytical, creative and practical; these three intelligences and ways of thinking are useful in everyday life; thinking skills can be improved by understanding the processes involved in thinking; meta-cognition is a part of higher order thinking.

The description above provided an affirmation that it was necessary to apply an innovative and meaningful learning model that was able to train students' higher-order thinking skills in science learning. One of the learning models that match the characteristics of developing students' higher order thinking skills was a project-based learning model (Anazifa,& Djukri, 2017; Kricsfalusy, George,& Reed, 2018; Manik, Sasson,Yehuda,& Malkinson, 2018). The Project Based Learning model has great potential to make the learning experience more meaningful. It facilitated students to investigate solving problems, student centered and produced real products real associated with technology(Jalinus, Nabawi, & Mardin, 2017; Rati, Kusmaryatni, & Rediani, 2017; Kricsfalusy, George, C., & Reed, 2018; Mihardi, Harahap, & Sani, 2013; Wiek, Xiong, Brundiers, & Leeuw, 2014). In making a work/product, students must involve their thinking skills. This was expected to train students' higher order thinking skills.

The stages of the project-based learning model used in this study include seven stages. The seven stages referred to include connecting with the problem, setting up the structure, visiting the problem, revisiting the problem, producing a product/performance, evaluating performance and the problem. Project-based learning has characteristics including learning that involves students in real and meaningful problems and the teacher acts as a facilitator who brings together student progress when they work towards solutions to find answers to problems in the learning. This will develop valuable skills in understanding the concepts of the lesson (Jusita,2019).

Based on the characteristics and advantages of the project-based learning model, this research determines the use of the project-based learning model in training high-level thinking skills of junior high school students in learning science. This study aims to describe students' higher order thinking skills through a project-based learning model in science subjects at SMPN 33 Makassar in science subjects. As for the benefits of this research, information about the level of students' higher-order thinking skills is used as a basis for fixing and developing forms of debriefing in science learning.

METHOD

This study is a quasi-experimental method with one group pretest-posttest design. Sample of this research were 35 students at SMPN 33 Makassar (Sugiyono, 2010). The steps of this study were as follows: conducting a pretest to measure the students' higher-order thinking skills before being given treatment; providing treatment in the form of applying the Project Learning Model in science learning; conducting posttest 1 to measure students' higher order thinking skills; providing treatment in the form of applying the Project Learning Model in the second part of science learning; held posttest 2 to measure students' higher order thinking skills. Data collection included the types of data collected through test. The tests used in this research were a standard test developed by the Center for Assessment and Learning of the Ministry of Education, Culture, Research and Technology. This test was multiple-choice which consisted of 65 items. The initial test aims to determine the students' initial higher order thinking skills (HOTS). The final test aims to determine the differences in students' higher order thinking skills obtained after learning through the Project Based Learning model (PjBL). The two tests were given in the same class.

All of these search data were analyzed quantitatively descriptive. The level of students' higher order thinking skills were categorized based on the acquisition of students' test scores.Calculation of students' higher order thinking skill was based on Yee *et al*., (2015).The categories of HOTS was showed on Table 1.

Table 1. Categories of students' higher order thinking skills (HOTS)

Score	Category
100-76	Excellent
75-51	Good
50-26	Enough
25-1	Poor

RESULT AND DISCUSSION

There were two stages of activity, namely the stage of giving the HOTS test and the treatment stage in the learning process. In this case, the HOTS indicators will be improved are the levels of applying (C3), analyzing (C4), and evaluating (C5). Students have been given three tests, where the first test was the pretest and the second test was the posttest 1 and the third test was the posttest 2. The following were the test results in graphical form as shown in Figure 1.

All students received the same pretest before the intervention of the project-based learning model. The data from the pretest results were obtained by students getting the lowest score of 9.68, while the highest was 48.39 with an average score of 28.53 from the ideal value of 100. This shows that the higher-order thinking ability of students is still very low. Meanwhile, the first stage of the post test obtained the lowest score of 31.67 and the highest score of 71.67 with an average score of 51.99. Furthermore, the second post-test obtained the lowest score of 30,43 and the highest score of 76,81 with an average score of 54,14. The score obtained from the test results on the students' pre-test, post-test 1, and post-test 2 was shown in Figure 1 and the mean score of student was shown in Figure 2.

Figure 2 showed that the students' mean score HOTS test increased from pre-test to post-test 1 and post-test 2. Furthermore, figure 2 gift information that the students' mean score HOTS test increased from pre-test to post-test 1 and post-test 2. These data indicate that learning science using a project-based learning model contributes to training and developing students' higher-order thinking skills. The results of students' higher order thinking skills tests were grouped into four categories, namely excellent, good, enough, and poor. The categorization of students' higher-order thinking skills is shown in Figure 3.

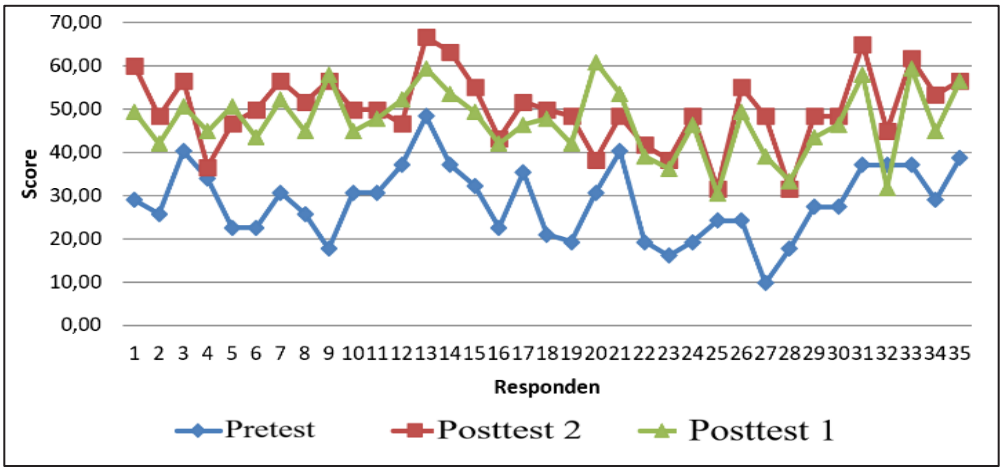

Figure 1. The score of students' HOT pretest-posttest

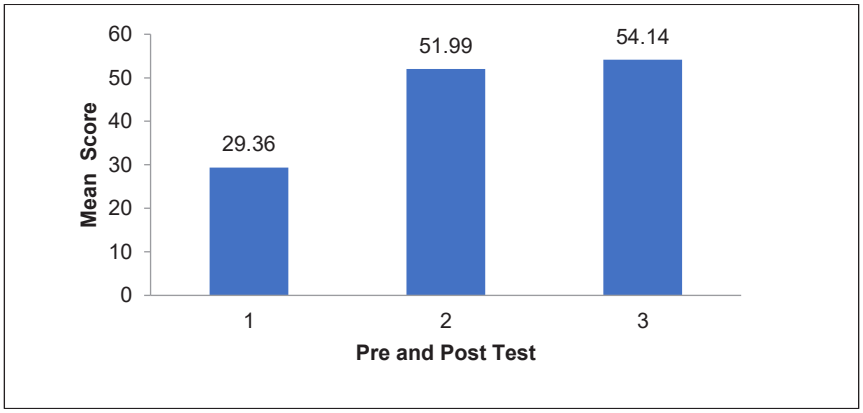

Figure 2. Mean score of students' HOT pretest-posttest

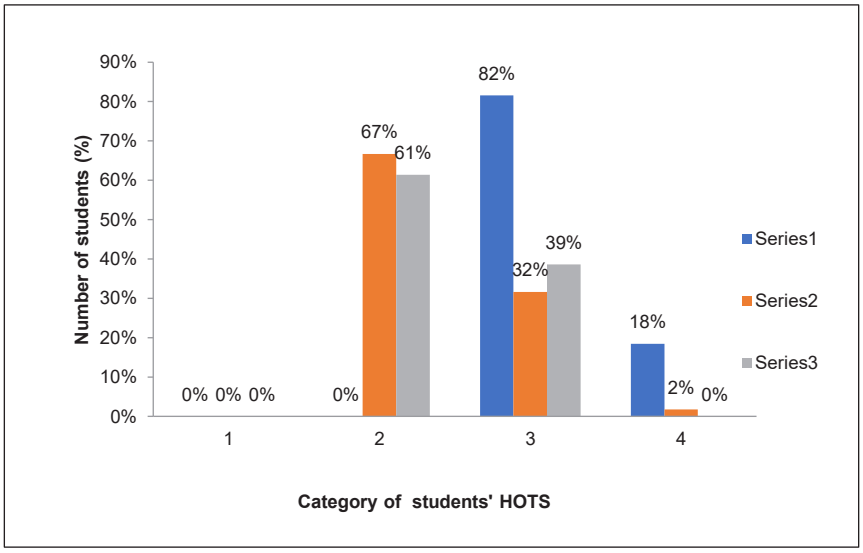

Figure 3. Categorization of students HOTS test result

The 2013 curriculum is directed to equip participants to improve HOTS, because HOTS can encourage students to think broadly and deeply about the subject matter. On the other hand, the revised 2013 curriculum has been directed to equip students with a number of competencies needed to face the 21st century, including: (1) critical thinking (critical thinking skills) aimed at enabling students

to solve various contextual problems using critical and rational logics; (2) creativity (creativity) encourages students to be creative in finding various solutions, designing new strategies, or finding ways that were not commonly used before; (3) collaboration (cooperation) facilitates students to have the ability to work in teams, tolerance, understanding differences, able to live together to achieve a goal; and (4) communication (communication ability) facilitates students to be able to communicate widely, the ability to capture ideas/information, the ability to interpret information, and the ability to argue in a broad sense.

The finding of research was in line with the results of the international study Program for International Student Assessment (PISA) which showed that the achievement of reading literacy, mathematical literacy, and scientific literacy achieved by Indonesian students is very low. Generally, the ability of Indonesian students is very low in: integrating information; generalizing case by case into a general solution; formulating real-world problems into subject concepts; and conduct an investigation. and the scientific literacy achieved by Indonesian students is very low. Generally, the ability of Indonesian students is very low in: integrating information; generalizing case by case into a general solution; formulating real-world problems into subject concepts; and conduct an investigation. and the scientific literacy achieved by Indonesian students is very low. Generally, the ability of Indonesian students is very low in: integrating information; generalizing case by case into a general solution; formulating real-world problems into subject concepts; and conduct an investigation.

The low results of the HOTS test at SMPN 33 Makassar were caused by the fact that students are not accustomed to working on HOTS questions as an instrument that can measure students' higher-order thinking skills, namely thinking skills that are not just remembering, understanding, or applying (apply). HOTS questions in the context of an assessment measure skills: transfer one concept to another, process and integrate information, find links from different types of information, use information to solve problems (problem solving), and critically examine ideas and information. Students were only used to working on routine cognitive questions. This statement was evidenced by the results of a review of items carried out by Directorate of High School Guidance for USBN (Mukhtar & Haniin, 2019).

The assistance for the 2018/2019 academic year on 26 subjects at 136 Referral High Schools spread across 34 Provinces showed that of the 1,779 items analyzed, most of them are at Level-1. and Level-2. From the 136 Referral High Schools, there was only 27 schools compiled HOTS questions as much as 20% of all USBN questions were made, 84 schools compiled HOTS questions below 20%, and 25 schools stated that they did not know whether the HOTS questions were prepared or not. This is not in accordance with the demands of the 2013 Curriculum assessment which further improves the implementation of HOTS assessment models. The 779 items analyzed were mostly at Level-1 and Level-2. Of the 136 Referral High Schools, only 27 schools compiled HOTS questions as much as 20% of all USBN questions were made, 84 schools compiled HOTS questions below 20%, and 25 schools stated that they did not know whether the HOTS questions were prepared or not. This is not in accordance with the demands of the 2013 Curriculum assessment which further improves the implementation of HOTS assessment models. The 779 items analyzed were mostly at Level-1 and Level-2. From the 136 Referral High Schools, there was only 27 schools compiled HOTS questions as much as 20% of all USBN questions were made, 84 schools compiled HOTS questions below 20%, and 25 schools stated that they did not know whether the HOTS questions were prepared or not. This is not in accordance with the demands of the 2013 Curriculum assessment which further improves the implementation of HOTS assessment models.

The HOTS questions measure the meta-cognitive dimension generally, not just measuring the factual, conceptual, or procedural dimensions. The meta-cognitive dimension describes the ability to connect several different concepts, interpret, solve problems (problem solving), choose problem solving strategies, find (discovery) new methods, argue (reasoning), and make the right decisions. In the context of HOTS, the stimulus presented must be contextual and interesting. Stimulus can come from global issues such as issues of information technology, science, economy, health, education, infrastructure, and others (Hakim, Liliasari, Setiawan, & Saptawati, 2017; Tuada & Suparno, 2021; Wartono, Diantoro,& Bartlolona, 2018; Zainudin & Pambudi, 2019). Stimulus can also be sourced from problems that exist in the environment around the school such as culture, customs, cases in the area, or various advantages found in certain areas. A good stimulus contains some information/ideas, which was needed to develop

the ability to find relationships between information, transfer information, and be directly related to the subject matter. However, HOTS assessment cannot be separated from HOTS learning. The teacher's task is not only to carry out HOTS assessments, but also to be able to carry out learning that can train students to have higher-order thinking skills. The main goal is to improve higher order thinking skills more effectively. But also must be able to carry out learning that can train students to have higher-order thinking skills. The main goal is to improve higher order thinking skills more effectively. But also must be able to carry out learning that can train students to have higher-order thinking skills. The main goal is to improve higher order thinking skills more effectively.

Learning is oriented to higher order thinking skills or HOTS, the teacher's role does not explain much, on the contrary, the teacher stimulates a lot of questions to encourage students' original thoughts to emerge. This statement is in line with the test results second as posttest stage 1, there was students who got the lowest score were 31.67, while the highest was 66.67 with an average score of 49.95 from the ideal value of 100. This result was not much different from the results of the posttest stage 2, namely students who scored the lowest is 30.43 and the highest value is 60.87 with an average value of 47.05. This showed that the higher order thinking ability of students has increased when compared to the results of the pretest although it was still relatively low. This showed that teaching higher order thinking skills is not easy. This statement is in line with the findings of Tuada & Suparno (2021) research which explains that Teaching higher order thinking skills has challenges. Teachers require persistent time and efforts in implementation. One of the related challenges concerns a teacher's teaching skills.

The increasing of students' HOTS score was due to the teacher has done a lot of question stimulation to encourage the original thoughts of students to emerge through learning project learning model with small group discussion method for eight meetings. Students are divided into several small groups consisting of 4-5 children in each group. After explaining the purpose of the discussion, the steps, and an outline of the things discussed, each group was asked to solve a problem in the students' worksheet that had been prepared by the teacher. The students' worksheet compiled by HOTS-oriented teachers. The results of group discussions were presented in a panel or class forum, where each group conveys the results of their discussion to other groups to be discussed together in a class forum, for 20 minutes then followed by questions and answers in the discussion. The results of the discussion and the content of the lesson were discussed and summarized by the students. This was in accordance with the statement John Dewey where project-based learning models allows students to make various choices in the learning process. Students work together on a variety of different project-related tasks, because project-based learning is meaningful, integrated, and active, teachers find more opportunities to challenge students at their own level of ability (Williams, 2017). Learners become experienced in doing project work, and challenge themselves to each other to ask more questions, find more learning resources, and create more informative projects (Doppelt, 2015; Haatainen & Aksela, 2021; Mihardi et al., 2013; Miller & Krajcik, 2019; Winarni & Purwandari, 2020).The project-based learning model make students do exploration, assessment, interpretation, synthesis, and information to produce various forms of learning outcomes (Doppelt, 2015). Project-based learning is a particular strategy in learning that changes or reverses the face of the traditional classroom (Jalinus et al., 2017; Wiek et al., 2014). This means that through this learning, classroom learning that generally uses conventional learning becomes more innovative. In project-based learning, students carry out investigations (investigations) through open-ended questions, applying knowledge to produce products. In addition, this learning is "set" so that students are more active in learning by working together in a group.

CONCLUSION

Students' HOTS were measured by a standard test developed by the Center for Assessment and Learning of the Ministry of Education, Culture, Research and Technology. This test was multiple-choice which consisted of 65 items The pretest results were obtained by students getting the lowest score of 9,68, while the highest was 48,39 with an mean score of 29,36 from the ideal value of 100. The test results second as posttest stage 1 showed that there was students who got the lowest score were 31,67, while the highest was 71,67 with an average score of 51,99 from the ideal value of 100. This result was not much different from the results of the posttest stage 2, namely students who scored the lowest is 30,43 and the highest value is 76,81 with an average value of 54,14. This result showed that the project-

based learning model contributed to increasing the HOTS of students at SMPN 33 Makassar.

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