Analysis of Students' Cognitive Ability in Solving Physics Problems on Parabolic Motion Material for Class XI Science at MAN 3 Bojonegoro

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Abstract

This research is a survey research with quantitative descriptive data type carried out at MAN 3 Bojonegoro. The population in this study was all students of class XI IPA MAN 3 Bojonegoro with a total sample of 129 students who were divided into four classes. The background of the problem in this study is the low problem-solving ability of students in solving physics problems on parabolic motion material. The results showed that 73.13% of students were in the high category for the factual dimension and 67.24% of the students were in the high category for the conceptual dimension. Students still have difficulty in solving cognitive questions at the evaluation level (C5) and creating (C6) with 24% of respondents answering. On cognitive questions at the Application (C3) and Analysis (C4) levels, the success rate of answering students' questions correctly is at the level of 90% and 9 4 5%. This shows that learning in schools is by national education goals which put learning objectives on Parabolic Motion material at the C4 level. These results are expected to be a reference for Physics Teachers at MAN 3 Bojonegoro to improve the learning process in the realm of High Order Thinking.

INTRODUCTION

Learning in schools makes students a decisive part of success in the learning process. The learning process is a process of achieving goals and a process of change to improve the cognitive, affective, and psychomotor abilities of students (Suhaida, 2018). Based on the results of the 2018 Program for International Student Assessment (PISA) survey, the ability of students in Indonesia for science and math skills is low, respectively, because they are ranked 74th out of 79 countries. The results of the 2018 International Student Assessment (PISA) measure the ability of 600,000 15-year-old children from 79 countries. This score is low because it is still below the average score of all participating countries of the Organization for Economic Co-operation and Development (OECD), which is 493 (PISA result, 2018). This is because the questions used in PISA cover the cognitive aspects of six levels of cognitive processes (Aida, 2017). So it can be concluded that the cognitive abilities of Indonesian students are still below the average of OECD countries.

The low cognitive aspect in schools makes the government enforce the 2013 curriculum to improve the quality of education in Indonesia and it is hoped that educators will be able to facilitate students in developing their cognitive abilities. This is supported by

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(Syaiful, 2018) that the 2013 curriculum is designed to improve high-quality performance through the learning process to create the abilities of students who have high quality. The cognitive aspect is one of the assessments of 2013 curriculum learning. Supporting this explanation (Rosa, 2015) states that the national education system in Indonesia adopts educational goals using learning outcomes from Benjamin Bloom called Bloom's taxonomy which has been defined by Anderson and is divided into three domains. namely the affective, cognitive, and psychomotor domains.

According to (Huda & Sinaga, 2012) six cognitive domains need to be considered for existence and continuity from the lowest, simple and concrete levels, namely from C1 to C6. The results of interviews conducted by researchers with physics teachers at MAN 3 Bojonegoro on 27 October 2022, namely David Widiyatma, S.Pd said that students' ability to solve physics problems on kinematics material was still relatively low. Of all the odd semester subject matter, this material shows the low ability of students to solve physics problems. Even though in the learning activities, examples of questions and exercises are always given, during the test the student's score is always low. Meanwhile, student learning activity in general is still very low in the learning process. Students also complained about the difficulty in using the many formulas and it was difficult to understand. This is also exacerbated by the enthusiasm and motivation of students who are still lacking.

The results of research (Sarkity, et al. 2016) many studies discuss students who have difficulty understanding the concept of wavelength; energy; the concept of entropy; heat engines, and the Carnot cycle on thermodynamics and translational motion. Several studies that discuss cognitive abilities use materials such as mechanical materials (Naufalina, et al. 2016); optics (Rosa, 2015); effort and energy (Rosa, 2017); temperature and heat (Siswanto, et al. 2017). Research on the cognitive abilities of students using Dynamic Fluids is still very minimal, even though the fluid is very close to the lives of students. Even the need for daily use of fluids, both liquids, and gases. According to (Khamzawi, et al. 2015) the concept of Dynamic Fluids is a concept that is very close to the lives of students. Several studies on students' cognitive abilities in solving problems include (Sari, et al. 2018); (Fathiah, et al. 2017); and (Khasanah, et al. 2015).

Apart from the results of the interviews, the researchers also analyzed the syllabus based on the indicators achieved from Competency standards and basic competencies. The results of the analysis obtained that in general, the achievement of indicators for all materials is generally the same using C3 and C4. However, the reality is found from the results of the interviews above, from all the odd semester materials this material shows the low ability of students to complete questions.

Based on these problems, it is necessary to determine cognitive abilities, namely by conducting analysis, so that it can help teachers to find out and take follow-up actions that will be pursued. The focus of the problem in this study is the cognitive ability of students in solving physics problems on parabolic graph material.

METHODS

The type of research conducted is survey research. According to (Nazir, 2003), the survey method is an investigative method used to obtain facts about symptoms existing and seek factual information from a group or an area. This research was conducted in October 2022 at MAN 3 Bojonegoro.

The research design used is the survey research with a quantitative descriptive type to describe the level of the ability of students to solve physics problems for Parabola Motion Material. Population the research consisted of 129 students in MAN 3 Bojonegoro. Researchers will examine some from the population, or take a sample using the Slovin formula.

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The data collection technique is using a survey technique where the technique of collecting data or information on a large population using a relatively small sample is carried out by conducting direct observations of ongoing observations. The data analysis technique used the descriptive analysis technique, which aims to provide a description or description of the research subject based on variable data obtained from certain subject groups.

The research instrument used is a question instrument aimed at students to measure and find out how far the students' ability in solving physics problems is. Researchers will examine some from the population, or take a sample using the Slovin formula, namely:

$$n = \frac{N}{1 + Ne^2}$$

Information:
n : the number of samples sought
N : total population
e : margin of error

RESULTS AND DISCUSSION

The study began by collecting data with a test instrument containing parabolic motion questions with cognitive levels of questions C5 and C6. The instrument was developed by making a grid of questions first and then arranging as many as 20 essay questions with a distribution of 10 questions at level C5 and 10 questions at level C6. The questions are packed with 5 items for each cognitive level so which is composed of 10 questions. This question is then used for 129 students from a minimum of 120 samples based on the calculation of the number of samples from Slovin. Of the 120 samples who worked on the questions, the researchers made 9 samples that did not complete the test because they were late. The measurement data are shown in Table 1.

Table 1. Presentation Table Based on Student Score Distribution

Question level	Score 1	Score 2	Score 3	Score 4	Score 5
C5	21.5%	25.2%	49.6%	4.7%	0.0%
C6	27.2%	52.6%	27.8%	2.4%	0.0%

These results indicate that all students almost did not complete the questions perfectly at levels C5 and C6. More than 70% of students were able to solve questions with score criteria 2 and 3. These results were then tabulated by descriptive statistics and obtained from the data shown in Table 2.

Table 2. Results of Descriptive Analysis of Questions

Statistical parameters	Question Level C5	Question level C6
Maximum score	75.00	73.00
Minimum score	34.00	34.00
Average score	62.15	56.32
Variance	52,20	37.07
Standard deviation	7.40	7.05

Students work on essay questions consisting of 5 questions at levels C5 and C6 according to the level of cognitive thinking in Bloom's Taxonomy. Problems compiled by physics subjects on parabolic motion material. Each question is checked using scoring criteria with a minimum score of 1 and a maximum value of 5 for each item. Participants' answers

were then tabulated and analyzed descriptively based on the cognitive level of the questions. Here are the results of the descriptive analysis:

1. Evaluating Level

    The questions at the evaluation level contain the application of the concepts and principles of parabolic motion to several matters relating to the application in everyday life. Based on the data in table 1.1 shows that as many as 0% of students can evaluate. The failure of students is not being able to provide theoretical input on the parabolic motion. This ability arises if students have high-level thinking skills, where students can relate aspects of law, concepts, and physics principles as a whole to the parabolic motion that is used as a problem in the given problem.

    As many as 4.5% of students can connect the laws, concepts, and principles of physics, but students have not been able to connect the aspects as a whole to provide an overview of the working principles that can be assessed. 49.6% of students were able to identify all the laws and concepts of physics used in the device being evaluated. Knowledge of the aspects involved in the device can be identified by students as a whole. All aspects of physics that exist have been successfully analyzed. This is based on the knowledge of analysis (C4) and application (C3) of very good students.

    The analysis of the answers shown in the questions is carried out in a hierarchical manner where students who are in the score criteria 4 mean they have met criteria 3 so that 54% of students can think more on C4.

2. Creating Level

    Creating level (C6), at these level students are asked to solve problems by designing tools and materials on the working principle of parabolic motion. The tools and materials that have been designed by the students are then asked to explain the systematic performance of the tool based on the physical aspects and mathematical calculations of the quantities related to parabolic motion. The results of observations in table 1.1 show that students are not able to provide a comprehensive picture of the tools that have been designed.

    The percentage in connecting the physics aspects to the design of the tools that have been made by students is still low where only 2.4% of students provide explanations. A total of 27.8% of students were able to identify the tools that had been designed. The low percentage is because the answers given by students still include aspects of physics that are not directly involved with the design of the tools they make. This is because the students' analytical skills are not good.

    From the observations, it can be said that the learning carried out by the Physics teacher at MAN 3 Bojonegoro is following national education standards where students can complete learning with high-level thinking skills at the C4 level. To improve the quality of education, data from research results can be used as a reference so that the physics learning process at MAN 3 Bojonegoro needs to be designed to involve more complex Higher Order Thinking skills

CONCLUSION

Based on data analysis, it can be concluded that the cognitive level of students is per national education standards in physics subjects for parabolic motion material, namely at level C4 (analyzing). At level C5 (evaluating) and level C6 (creating) students managed to evaluate according to laws, principles, and concepts but still separately, resulting in students who failed to provide a comprehensive picture of the principle of parabolic motion.

SUGGESTION

Suggestions for researchers, especially in the field of education, to give practice questions more often to students in developing students' cognitive abilities.

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