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Analysis of Prospective Teacher Students Errors in Making Math Test Instruments Based on Bloom's Taxonomy Revised

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ABSTRACT: This study aims to describe the errors of prospective teacher students in making math test instruments based on cognitive levels from the Bloom's Taxonomy Revised (BTR). BTR consists of LOTS (C1-C3) and HOTS (C4-C6) levels. This research included descriptive qualitative research. The subjects of this study were 19 prospective teacher students, namely the mathematics education department in the Mathematics Learning Evaluation course. Based on the results of the study, it was obtained that prospective teacher students made mistakes at both levels but more at the HOTS level. At the LOTS level, it is on the error level C3; at the HOTS level, it is spread at all levels, namely C4-C6. An indication of error that often arises is that prospective teacher students cannot compile questions according to their level of cognition. The questions made are often still below the level they should be. The level of the questions made is still below the level that it should be.

Keywords: math test, evaluation, Bloom's Taxonomy Revised, HOTS

INTRODUCTION

Evaluation plays an important role in learning success, especially for teachers. For teachers, evaluation serves as a tool to evaluate the success of learning strategies in achieving learning goals (Evendi and Verawati, 2021; Muji et al., 2021; Sukardi et al., 2022). Evaluations also provide an overview of student performance to map which areas need to be enhanced by adapting learning according to the character of students (Asri et al., 2022; Wuryandani and Herwin, 2021). Therefore, teachers should understand the process of preparing evaluation instruments by always paying attention to the quality of the instruments.

The Kurikulum Merdeka Indonesia's implementation urges educators to create high-quality assessment instruments. By promoting the higher-order thinking skills (HOTS) process, teachers should be able to create high-quality assessment tools (Hadiati et al., 2021). Evaluation tools are also viewed as important by the educational programs shift to assess students' growth of HOTS. In general, the Merdeka curriculum emphasizes teacher proficiency to develop assessment tools as a way to evaluate the learning results of the students (Harianda and Junedi, 2021).

However, prior studies suggest numerous educators in Indonesia continue to have difficulties while implementing the Merdeka curriculum, specifically concerning creating assessments (Pratikno et al., 2022). One of the issues teachers faces is that they feel it is difficult and less qualified to prepare evaluations that help students through the HOTS improvement process (Purwasih, 2020). This is a priority for repair since it presents an educational obstacle for Indonesia. Furthermore, this condition can serve as a guide for efforts to improve teacher quality as soon as possible.

Enhancing university education might be the first step toward raising the quality of teachers. The education major is one of the best programs for producing future teachers. To do this, potential teacher students must learn how to create powerful evaluation questions right away (Badjeber, 2022; Novita et al., 2022; Sumanik et al., 2021). It is expected to ensure that prospective teachers' students will be accustomed to processing questions and can create questions soal (Marhayati and Huda, 2020). Future educators must acquire the ability to create assessment tools that encourage students to think critically (Sulaeman, 2019).

Considering student cognitive levels, assessments that promote Higher-Order Thinking Skills (HOTS) must be developed. Bloom's Taxonomy is a cognitive framework. At first, Bloom's Taxonomy divided high-level thinking skills—such as application, analysis, synthesis, and evaluation—from low-level cognitive activities, such as knowing and comprehension. By examining Bloom's Taxonomy's cognitive processes more deeply Krathwohl (2002) improved it. There are six cognitive levels in the Bloom's Taxonomy Revised (BTR): remember, understand, apply, analyze, evaluate, and create(Kang, 2023; Kilicoglu and Kaplan, 2022; Larsen et al., 2022; Widiana et al., 2023).

Research related to the application of BTR has been a lot done but more focused on the student's ability aspects. Previous research with teacher subjects focused on results quantitatively like Febrilia (2019). The research focuses on the number/percentage of errors at the cognitive level. Research with other subjects such as prospective teachers has also not been found. This potential subject should also be investigated on this subject. An overview of the problem of preparing an evaluation based on BTR with the subject of a candidate teacher is considered important because it can be used as a measure of the initial problems that arise. It is hoped that future teachers will understand what the problem is and be able to solve it before becoming teachers in real life.

Although many studies have been done on the application of BTR, it has primarily focused on aspects related to students' abilities. Previous teacher-focused research, such as the Febrilia (2019), focused on quantitative results. The number of cognitive errors is the main topic of the study. Other subjects, such as potential instructors, have not been studied. Because it can be used to evaluate the early issues that occur, an overview of the difficulty of creating a math test based on BTR with a candidate teacher as the subject is seen to be important(Bodger, 2023; McDonald and Fotakopoulou, 2023; Yilmaz et al., 2023). Before they become actual teachers, it is hoped that prospective teachers will see the issue and be able to solve it.

METHOD

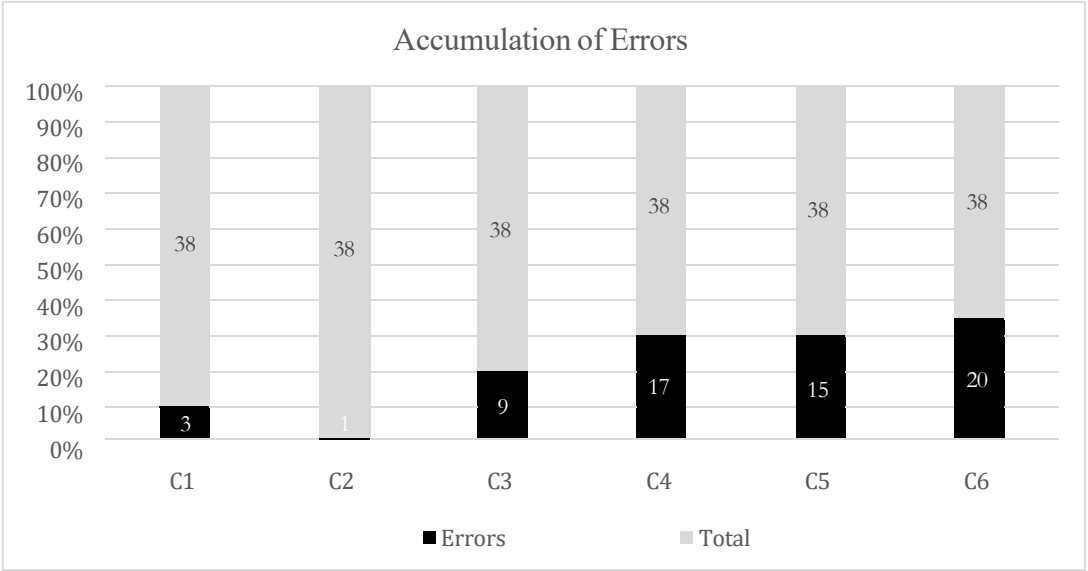
The research method used is descriptive research with a case study design. The objective of this study is to describe any errors made by a student of the prospective teacher in mathematical education when developing an mathematics test based on the BTR. According to Krathwohl (2002), the BTR cognitive level consists of Low Order Thinking Skills (LOTS) and High Order Thought Skills (HOTS)(Hadzhikolev et al., 2022; Siu et al., 2022). The LOTS level consists of remember (C1), understand (C2), and apply (C3). Meanwhile, the HOTS level comprises analyze (C4), evaluate (C5), and create (C6) levels.

The research included 19 students from the Mathematical Learning Evaluation course. The participants were given two examinations in which they were required to create six items in math test with junior high school or senior high school topics based on their BTR level(Caemmerer et al., 2023; Ersozlu et al., 2022; Gliksman et al., 2022; Mervis, 2022). At each level, the total number of student responses was 38. The researchers analyzed and classified the study's results according to the two tests, finding the similarity of errors. The researchers used the interview data to confirm the data's validity, ensuring that the participants' oral and written accounts were equal.

RESULT AND DISCUSSION

Based on the results of the analysis of the math test instruments made, students make mistakes in composing questions from each of their cognitive levels. Complete results can be found in Diagram 1 below.

Diagram 1. Accumulation of errors according to the cognitive level of BTR

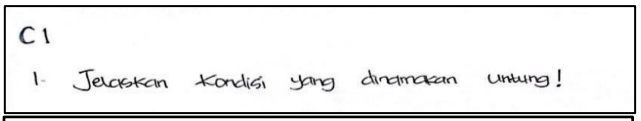


Based on Diagram 1, errors occur at all levels with unequal distribution. The highest number of errors occur at all HOTS levels, with the number of errors above 40% at each level (C4 = 45%, C5 = 39%, and C6 = 53%). These errors are examined by pattern and reported as follows at each level.

Level C1 (Remember)

At this level, most students are already able to develop questions correctly. The error that occurred was an error in using the operational word. The use of the operating word at this level was replaced with the word at C2. It suggests that the participants have not yet been able to distinguish what concepts are remembered and which concepts are understood. In Figure 1, the subject elaborates on Social Arithmetic but does not match level C1. This is because answering this question not only requires consideration of the definition of profit but also requires a more complete explanation of both the definitions of the sale price, and the purchase price, and the relationship between the two definitions. So, in this case, the issue is more organized into the C2 level.

Figure 1. Level C1 error



Explain the condition called profit!

Level C2 (Understand)

At this level, only one subject makes mistakes. Figure 2 shows participants who answered the C2 question regarding the sagitta on the Circle topic while remaining at the C1 level. It's because answering the question requires only recalling the definition of sagitta. The subjects believe that to comprehend the sagitta, they must first comprehend the chord and the line that is perpendicular to it. This claim, however, is insufficient because it is sufficient to seek the definition of sagitta. At this point, the subject should write a question that leads to the process of comprehension by asking questions such as "How to determine the sagitta?" To answer the question, students must not only remember the definition of a sagitta but also understand how processes such as making chord and perpendicular lines straight determine sagitta. In general, when there is already a process of comparing how many concepts and connecting between concepts, the level of understanding can occur.

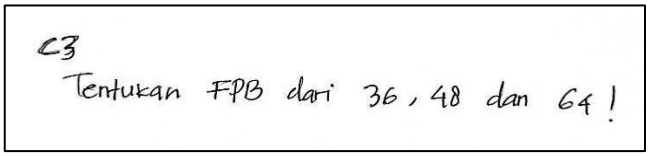
Figure 2. Level C2 error

What is the sagitta in circle?

Level C3 (Apply)

At this level, there are nine errors found. There were two cases found, seven questions that were not yet applied, and two questions that belonged to the C2 level. In the first case, as can be seen in Figure 3, the question arranged is just a simple application of the formula. It can even be classified as a C1 level if given to students who have a high level of cognitive experience. Applicative meanings can be understood more widely, such as applications to real life or applications to another topic outside mathematics.

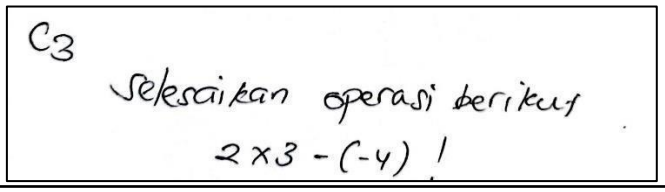
Figure 3. The 1st Level C3 error



Determine the greatest common divisor of 36,48, and 64!

In the second case, the participant makes questions at level C3 but still belongs to level C2. The questions that are formulated only require a process of understanding the formula or the rule. Level C3 should be able to apply the principle and the formula contextually. Students of prospective teachers may face the challenge of finding innovative and exciting ways to develop questions that focus on the application and analysis of mathematical concepts (Pratiwi, 2022). As in Figure 4, the subject judges that this issue already includes applications because of the principle of multiplication and reduction. This is probably a C3 level for elementary school. The improvement suggestion for this matter is to apply it to the matter in a real case.

Figure 4. The 2nd Level C3 Error



Determine the result of the following operation:
$2 \times 3 - (-4)$!

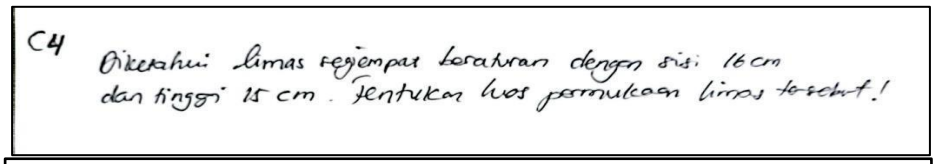
Level C4 (Analyze)

At this level, there are 17 errors found. The majority of errors occur because there is no process of analysis, so it is still at the LOTS level (level C3). Questions for level C4 require a process of sorting and choosing the right strategy so that students not only remember, understand, and then apply. Sometimes the analysis process also requires new information that must be obtained by combining concepts and strategies. That's what makes level C4 a High Order Thinking Skills level (HOTS).

Note Figure 5, the subject selects the Pyramid's surface area. The topic submits the question because, to calculate the area of a Pyramid, the student must know the Pyramid's latitude formula and be able to calculate the height of the triangle on the Pyramid's vertical side. The subjects believe that the scan is complicated and necessitates an analytical process. In general, the subject analysis process is minor because the main procedure that arises is the formula application. Furthermore, if students are already aware of Pythagoras' triple concept (8-15-17), the analytical procedure is shortened. In this case, a teacher must first improve the quality of the lessons that are

taught in the classroom (Evendi and Verawati, 2021; Santi et al., 2021). To that end, it is critical to examine the role of the teacher in increasing one's capacity and improving one's evaluative quality (Destiniar et al., 2020; Listiani and Sulistyorini, 2020; Sujadi et al., 2021).

Figure 5. The Level C4 Error

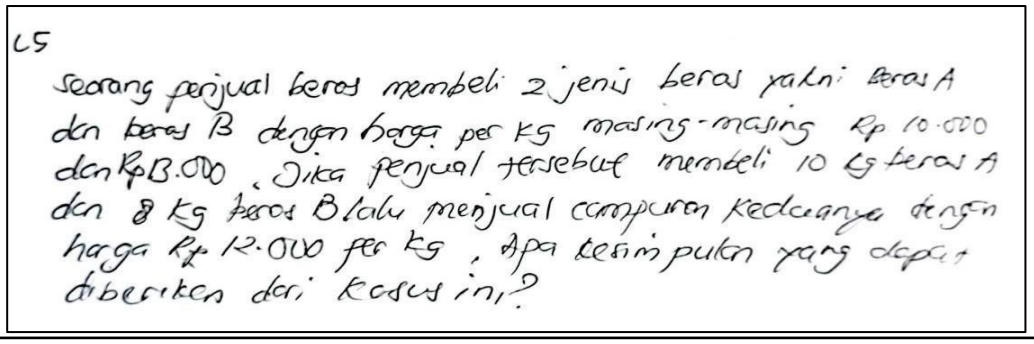


It is known that the pyramid has sides of 16 cm and height of 15 cm. Determine the surface of the pyramid!

Level C5 (Evaluate)

There are 15 mistakes discovered at this level. The first error discovered was an issue that had not yet been evaluated and had caused the analysis process to be stopped. At this level, the issue should lead to the process of developing a standard of assessment that will serve as a reference for consideration or assessment. The examination of data suitability, data adequacy, and data consistency are some of the issue indicators that involve the level of review. The evaluation process may also begin with criticism and verification of the data obtained in contrast with an identified standard or universal truth.

Figure 6. The 1st Level C5 Error



A seller of rice buys two kinds of rice, rice A and rice B. Seller buys rice A for Rp 10.000 and rice B for Rp 13.000. If he buys 10 kg of rice A and 8 kg of rice B and sells a mixture of them for Rp 12.000, what conclusion can be drawn from this case?

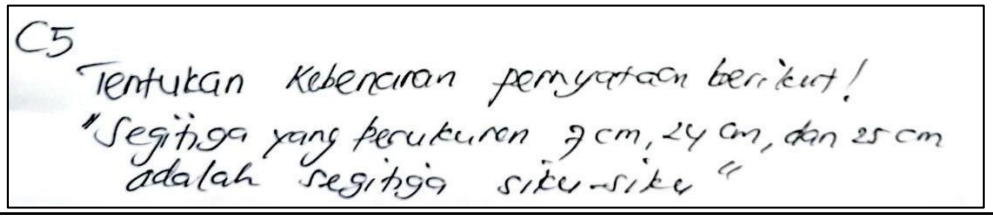
In figure 6, the subject asks predictive questions where which tends to lead to the analysis process. The subject tried to create a standard of profit or loss but the process was not yet visible. The above can be revised to C5 if the standard is emphasized, such as the editing of the subject is replaced with a sentence like Figure 7.

Figure 7. C5 Correction Example

A rice seller buys two types of rice, 10 kg rice A and 8 kg rice B, at the price of Rp. 10,000/kg and Rp. 13,000/kg. The seller wants a profit so he sells the mixture of rice for Rp 12,000/kg, is the seller's move, right? Give me your excuse!

The second error that was discovered involved LOTS, C2, and C3. Six problems are highlighted that simply show the cognitive level of knowledge and implementation of the formula. Figure 8 shows that the issue has previously been requested for examination, but the evaluation procedure does not include enough of the analysis process. Using Pythagoras' understanding of the Pythagoras triples idea, this subject can also be classified as C2. This is also an attempt to apply the concept of Pythagoras' Triples by using $a^2 + b^2$ and $c^2$where a, b,c are the triangle sides with the longest sides being c's. The triangle benchmark was established by the subjects as $a^2 + b^2 = c^2$. However, the review procedure with this criterion is unlikely to occur because the process of remembering and understanding the concept of Pythagoras triples makes it easier to solve this issue. At this level, errors indicate that the student has difficulty making the right issue. Previous research has shown that a teacher's ability to formulate HOTS issues (including C5) is still low. (Harianda and Junedi, 2021; Musdalifah et al., 2020). The difficulty in making these questions comes from the teacher's limited understanding of the characteristics of the HOTS question (Pertiwi, 2020; Puspa et al., 2020).

Figure 8. The 2nd Level C5 Error

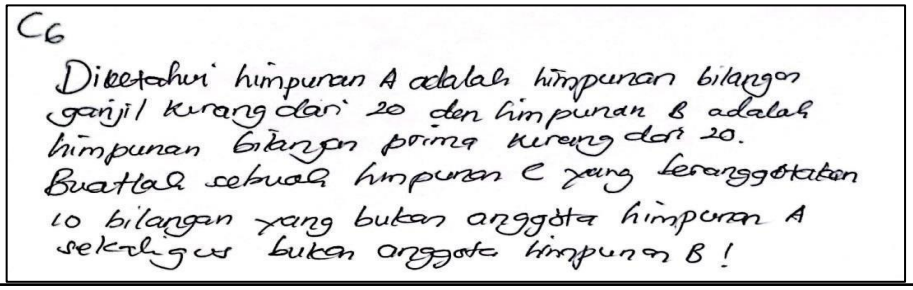


Determine the truth of the following statement!
"The triangles of size 7, 24, and 25 are the right triangle "

Level C6 (Create)

At this level, there are 20 errors found. The majority of the errors found are issues that are arranged to stop at level C4. The creation process has to produce something new, such as a new idea, a new hypothesis, a new strategy, or a new outcome. When the subject does not facilitate it, the cognitive process stops at the lower level. In Figure 9, the subjects that are arranged are already trying to stimulate creativity. It's seen on the issue of asking students to create a new set. But because there are conditions then the innovation process will be limited and focus on analyzing the conditions.

Figure 9. The Level C6 Error



A is a set of odd numbers less than 20 and B is a set of prime numbers less than 20. Create a new set namely C that has 10 members which is not related to either A or B !

The problem at the C6 level is identical to the problem of open-ended creative thinking. It is important to remember, that matters that focus only on remembering and conventional procedures can potentially impede the development of students' reasoning and creativity (Febrilia, 2019). Besides, it affects students' decreased interest in mathematics so they are reluctant to engage in developing creative solving skills such as the C6 level. (Mutmainah, 2021; Silvia et al., 2021). In general, these results are in line with Harianda & Junedi (2021) which shows that teachers' ability to make HOTS issues is still low. One of the reasons is that teachers are not used to organizing HOTS questions. Teachers frequently use other people's questions or questions from the Internet that are not HOTS level as an evaluation instrument. (Mellawaty et al., 2022).

CONCLUSION

According to the study's findings, students make mistakes at both levels, but more so at the HOTS level. The most errors at the LOTS level are at the C3 level, where the challenges are still easy in memory and comprehension. Errors at level C3 also imply that many errors happened during the transition from LOTS to HOTS. The mistakes are distributed equally from C4 to C6 at HOTS. The structured questions at level C4 still belong to LOTS and do not highlight the process of analysis. Finally, students at the C6 level continue to struggle with creating open-ended topics that create creativity and innovation. The majority of errors are created by Prospective Teacher Students who are unable to formulate topics based on their cognitive level. This study includes limitations in terms of research subjects that are still in junior grade (5th semester) and places that are limited to one university. Researchers can then choose a variety of subjects, such as high-level students from various universities or students in the teaching profession (PPG).

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