Jurnal Penelitian Pembelajaran Fisika
Vol. 15 Issue 4 – October 2024, p385-391
p-ISSN 2086-2407, e-ISSN 2549-886X
Available Online at http://journal2.upgris.ac.id/index.php/JP2F
DOI: 10.26877/jp2f.v15i4.874

Analysis of Students' Questioning Skills During Discovery Learning: A Descriptive Study Based on The Revised Bloom's Taxonomy Framework

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Received: 24 July 2024. Accepted: 24 August 2024. Published: 31 October 2024.

Abstract. The problem in this study is the lack of questioning skills based on cognitive process dimensions and knowledge dimensions. This research aims to analyze questioning skills through students' written work using the revised Bloom's Taxonomy framework, specifically the cognitive process and knowledge dimensions. The participants were 32 students (15 males and 17 females) from class XI MIPA 3 at a high school in Bandung. This descriptive study employed documentation analysis using Google Forms for individual questions and worksheets for group questions. The results depict students' cognitive processes at the levels of remembering, understanding, applying, analyzing, evaluating, and creating as 18.25%, 47.44%, 9.49%, 18.25%, 2.92%, and 3.65%, respectively. In terms of knowledge dimensions, the percentages for factual, conceptual, procedural, and metacognitive knowledge were 24.82%, 72.99%, 2.19%, and 0%, respectively. It can be concluded that questioning based on cognitive processes is distributed across all levels from remembering to creating, while questions based on knowledge dimensions are predominantly conceptual.

Keywords: questioning skills, discovery learning, revised bloom's taxonomy

1. Introduction

According to Sudjana, active learning is a process of teaching and learning where students engage both intellectually and emotionally, allowing them to participate actively in the learning activities[1]. Essentially, asking and answering questions is a form of learning [2]. Knowledge begins with "asking" [3]. According to Rosalia in Huda [4], characteristics of active students include: frequently asking questions, willingly completing assignments, being able to answer questions, enjoying being given learning tasks, and so forth. Based on this, one indicator of student activity is questioning.

Questioning is a primary strategy in contextual learning approaches [5]. Sa'ud defines questioning skills as questions that explore or create knowledge in students [6]. Questioning activities can train students to identify and solve problems. Mufarokah outlines the goals of questioning skills for students as: (a) to develop their thinking abilities; (b) to motivate them to interact; (c) to practice divergent thinking; (d) to practice expressing opinions [7].

In research by Arsyad et al., questioning skills of students in a school were found to be low for regular classes, and the quality of questions remained at a low cognitive level [8]. A lectures rarely lead to student questions, whereas active learning models such as PjBL, discovery learning, or problem-based learning typically involve at least one representative from each group asking questions [9–11]. Based on Bloom's revised taxonomy, student questions are still dominated by C2 (understanding) and conceptual questions.

In the research conducted, the researcher measured questioning skills based on several indicators, namely questions based on the dimensions of cognitive processes and the dimensions of knowledge. To develop students' activeness and questioning skills, a suitable learning model is needed. According to

Ruseffendi [12], "Discovery learning is a learning model that organizes teaching in such a way that students independently acquire knowledge that was previously unknown to them, partially or entirely discovered by themselves." Meanwhile, Kurniasih, et al., explain that the discovery learning model is a learning activity that occurs when the lesson is not presented in its final form but is expected to be organized by the students themselves [13].

This is supported by findings from Widyanti, A., which show that the level of students' questioning skills increased with an average score of 86.66%, categorized as highly skilled [14]. Meanwhile, research conducted by Sofwan, M. explains that after the implementation of the discovery learning model, there was an improvement in every meeting of cycles 1, 2, and 3 with levels of 46, 51, 78, and 78, 86, and 85 [15]. This proves a significant improvement after implementing the discovery learning model in the second cycle, achieving a "good" category with a class success criterion of 75. Therefore, the discovery learning model was chosen to develop students' questioning skills.

To implement discovery learning, six steps need to be followed: stimulus or providing stimulation, problem identification, data collection, data processing, verification, and drawing conclusions. This learning model encourages students to discover something through a series of data or information obtained from observations or experiments [16].

This research is conducted to understand students' questions based on the dimensions of cognitive processes and their knowledge dimensions. In the discovery learning model, questioning skills are not just an auxiliary tool but also a key element that supports the entire learning process. Therefore, it is essential to train and develop students' questioning skills so that they can achieve their optimal learning potential.

2. Method

This research uses a descriptive method, utilizing data from observation sheets sourced from Google Forms and LKPD (Student Worksheet) in the field, involving 32 students (15 males and 17 females) from SMA Bandung, specifically class XI MIPA 3. In particular, Sudjhana (2001) outlines seven steps in qualitative research: problem identification, problem limitation, problem focus determination, research implementation, data processing and interpretation, theory emergence, and reporting of research results. The research was conducted in a single meeting in February 2024 using the discovery learning model on the topic of temperature and heat.

The research instrument is a tool chosen and used by the researcher to systematically and conveniently collect data for the research activity [17]. The instruments used in this research are documented questions from Google Forms, LKPD, and a question documentation sheet from students. The documentation sheet was obtained from the research documentation of Zamzani [18]. The written questions obtained were measured based on the dimensions of cognitive processes and knowledge dimensions.

According to Moleong, the activity of analyzing research results involves the process of examining all data from research instruments, such as notes, documents, recordings, etc., which is referred to as data analysis activity [19]. According to Ghozali (2009) in Sanaky, M.M. [20], to measure whether an instrument is valid, a validity test can be used. Thus, the instrument must be validated, and the validated instrument includes the assessment rubric for linguistic aspects and topic suitability. The treatment given to the students involved providing them with a learning video stimulus, which they watched. Then, the students were asked to write down the questions that came to mind in a Google Form provided. Since these questions were made by each individual, they are referred to as individual questions. Next, the students were asked to work in groups on practical exercises given by the teacher and discuss their practical results. During the group discussions, students were asked to write down the questions they thought of and then write them in the LKPD. These questions will be considered as group result questions. Therefore, there are two types of questions, namely individual questions and group questions.

The questions from several instruments were then categorized separately in the question documentation sheet, namely the dimensions of cognitive processes and knowledge dimensions. The number of questions was calculated using the formula provided by Nuraini, F., and categorized according to the revised Bloom's taxonomy [8]. This categorization method uses check marks for questions that fall into a specific category. The analysis of these questions was then validated by six different validators. This question categorization is also based on linguistic aspects and topic suitability, but this research does not discuss the aspect of writing style due to the difficulty in measuring it. Finally, the results of the question analysis were calculated and grouped based on their categories.

3. Result and Discussion

The research produced a total of 137 written questions, which were analyzed as follows:

3.1 *Number of student Questions*

Number of questions asked by students, categorized by gender, is displayed in Table 1 below.

Table 1. Percentage of student questions.

Gender	Number of Questioners	%
Male	13	40.62%
Female	15	46.88%
Total	28	87.5%
Total Student	32	100%

Table 1 shows that 28 out of 32 students asked questions during the class session. Four students did not ask any questions. The reasons included technical issues with signal and devices for three students and one student not having any questions to ask.

3.2 *Questions Based on Cognitive Process*

Questions were categorized according to cognitive processes: Remembering (C1), Understanding (C2), Applying (C3), Analyzing (C4), Evaluating (C5), and Creating (C6), and presented in Table 2.

Table 2. Results of individual question data processing.

Cognitive Level	Σ	%
C1	18	19.57%
C2	50	54.34%
C3	10	10.87%
C4	11	11.96%
C5	3	3.26%
C6	-	-

As shown in Table 2, more than half of the student questions were categorized as C2 (Understanding) with a percentage of 54.34%, indicating that students' questions were predominantly at a lower cognitive level. This is likely because the questions were stimulated by the video content provided by the teacher, leading to a predominance of understanding-level questions. There were no questions categorized under C6 (Creating), suggesting a need for stimuli that encourage higher-level cognitive questioning.

No individual questions reached higher cognitive levels, which might be due to the nature of the video content not prompting C5 (Evaluating) level questions. In addition to individual questions, questions were also obtained from group discussions, as represented in Table 3.

Table 3. Results of group question data processing.

Group Name	Cognitive Process					
	C1	C2	C3	C4	C5	C6
Group 1	1	2	1	3	-	1
Group 2	-	6	1	1	-	-
Group 3	-	5	-	2	1	-
Group 4	-	8	-	4	-	-
Group 5	-	2	-	6	1	-
Total	1	23	2	16	2	1

Table 3 illustrates the cognitive levels of questions asked by students in groups. Group 4 asked the highest number of questions, but these were predominantly in the C2 (Understanding) category, indicating a lower cognitive level. Other groups also showed a predominance of lower cognitive questions, except for Groups 1 and 5. Group 1 had an equal number of questions in both lower and higher cognitive levels but had the most questions in the C4 (Analyzing) category. Group 5, on the other hand, had the most questions in the higher cognitive level, specifically C4 (Analyzing).

Only one question was categorized as C1 (Remembering) from Group 1. Group 1 generated various question categories but none at the C5 (Evaluating) level. An example of a C6 (Creating) question from Group 1 is:

"How can we make a bridge stronger and less prone to holes?"

This question involves creating innovative strategies or solutions for bridge problems.

An example of a C5 (Evaluating) question is:

"How should we calculate the distance for the metal in a bridge to account for expansion?"

This question evaluates solutions for metal calculation to prevent expansion effects on the bridge.

C4 (Analyzing) questions were present in all groups. For example, Group 2 asked: "Why can significant temperature changes between water and a glass cause the glass to break?"

This question requires understanding the connection between temperature, expansion, glass material knowledge, and the mechanism causing the glass to crack, placing it in the C4 category.

There is a noticeable shift in cognitive levels of student questions during group discussions. While questions still predominantly fall under C2, the percentage of these questions decreased, and there was an increase in higher cognitive levels. Overall, individual and group questions are mostly in the C2 (Understanding) category. The percentage of higher cognitive level questions in group work (40%) is higher compared to individual questions (13.05%).

High-level cognitive questions from individual responses were posed by Group 3, which also contributed C5 (Evaluating) questions. However, Group 1 showed C6 (Creating) questions but none at the C5 level. Group 5 also included C5 questions, while no individual questions reached C5. This suggests that group discussions may positively influence the formulation of higher- level cognitive questions, as students tend to ask more complex questions in group settings compared to individually. This finding is in line with research [21,22].

3.3 *Questions Based on Knowledge Dimension*

Questions were categorized into factual, conceptual, procedural, and metacognitive dimensions and quantified as shown in Table 4.

Table 4. Distribution of individual questions by knowledge dimension.

Knowledge Dimension	Σ	%
Factual	*23*	*25%*
Conceptual	*69*	*75%*
Prosedural	-	-
Metacognitive	-	-

Table 4 shows that no students asked questions classified under procedural or metacognitive dimensions, likely because the learning process did not include elements that would lead to questions in these categories. Conceptual questions were the most dominant as the learning stimuli directed students towards generating conceptual questions. The questions from each group, categorized by knowledge dimension, are displayed in Table 5.

Table 5 provides an overview of the knowledge dimensions in each group. Conceptual questions dominate across groups, which is attributed to the use of virtual labs (Musschenbroek) during group practical sessions. If practical sessions were conducted using factual media or direct methods, a broader range of factual questions might emerge.

Table 5. Distribution of group questions by knowledge dimension.

Group Name	Knowledge Dimension			
	Factual	Conceptual	Prosedural	Metacognitive
Group 1	2	3	1	
Group 2	1	7	1	
Group 3	-	6	1	
Group 4	5	7	-	
Group 5	2	7	-	
Total	10	23	3	

All groups except Group 3 asked factual questions. Group 3, however, contributed procedural questions. Procedural questions were only posed by Groups 1, 2, and 3, while Groups 4 and 5 focused more on analysis and conceptual issues. Group 3 did not present any factual questions, whereas Groups 1 and 2 showed a variety of knowledge dimensions in their questions.

No metacognitive questions were asked, as the learning process did not target metacognitive aspects. However, there was a discrepancy between Table 4 and Table 5 regarding procedural knowledge. Table 4 shows no procedural questions, whereas Table 5 includes 3 procedural questions arising from group practical tasks. The final distribution of knowledge dimensions is as follows: factual (34 questions, 24.82%), conceptual (100 questions, 72.99%), and procedural (3 questions, 2.19%).

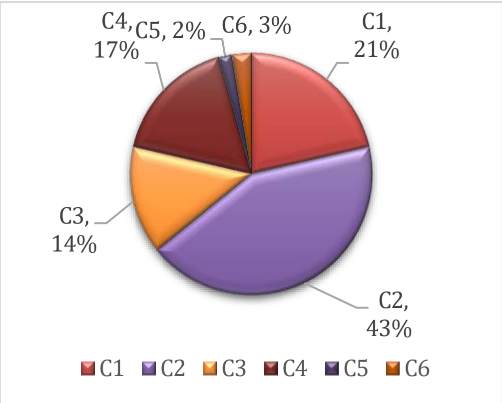

Figure 1. Distribution of questions based on bloom's taxonomy.

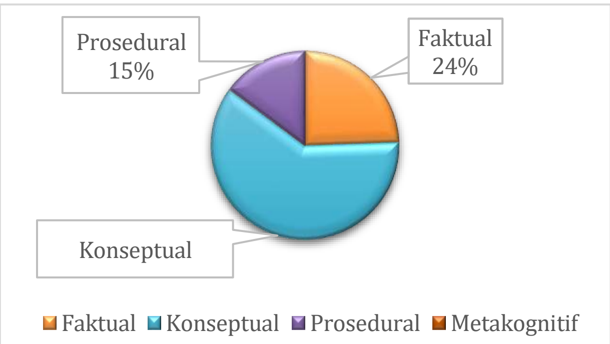

Figure 2. Distribution of questions based on knowledge dimension.

Figures 1 and 2 depict the overall distribution of questions by cognitive level and knowledge dimension. Questions were primarily dominated by C2 (Understanding), making up 53% of the total, while conceptual questions were the most prevalent in terms of knowledge dimensions. This suggests that while student questions predominantly fall within lower cognitive levels, there is potential for development into higher cognitive levels, as indicated by the 20% of C4 (Analyzing) questions. Previous research by Syarifah, L., et al. indicated higher percentages of C3 and C4 questions, whereas this study showed higher percentages for C5 and C6 questions compared to earlier studies. Teachers can guide students to formulate questions in desired categories, such as higher cognitive levels, by implementing processes that encourage such questions. The dominance of question types will align with the instructional methods used by the teacher. Thus, the discovery learning model can generate questions at both lower and higher cognitive levels depending on the instructional process provided by the teacher.

4. Conclusion

The study reveals that student questions span across cognitive levels from C1 to C6, with a predominance in C2 (Understanding). To enhance the cognitive level of questions, stimuli that direct students towards higher cognitive processes are necessary. The knowledge dimension analysis shows a high dominance of conceptual questions. Expanding question categories could be achieved by incorporating practical sessions with factual tools. To encourage higher-level cognitive questions, stimuli targeting high cognitive processes are essential. Future research should consider the time required for comprehensive analysis due to the extensive nature of the study.

Acknowledgement

The author extends sincere gratitude to all parties who contributed to this research, both directly and indirectly. Special thanks are due to SMAN Bandung for providing the opportunity for the research from the preliminary phase through to its completion. Appreciation is also given to the supervising lecturer for offering valuable advice, feedback, and constructive criticism throughout the study.

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