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HIGHER-ORDER THINKING SKILLS ANALYSIS OF MADRASAH ALIYAH STUDENTS IN BIOLOGY LEARNING

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ABSTRAK

Adanya tantangan pada pembelajaran abad 21 mendorong lembaga pendidikan untuk mampu mencetak generasi muda yang tidak hanya menguasai ilmu pengetahuan tetapi juga memiliki kemampuan berpikir tingkat tinggi (HOTS). Salah satu cara yang dapat ditempuh untuk mengembangkan kemampuan berpikir tingkat tinggi adalah dengan memberikan latihan berbasis HOTS. Keterampilan berpikir tingkat tinggi adalah kemampuan menganalisis, mengevaluasi, dan menciptakan informasi yang diperoleh untuk menjawab masalah. Tujuan penelitian ini adalah untuk menganalisis kemampuan berpikir tingkat tinggi siswa Madrasah Aliyah di Kabupaten Pati dalam pembelajaran biologi. Penelitian ini merupakan jenis penelitian kuantitatif. Data diperoleh dengan mengisi instrumen tes berupa soal pilihan ganda berbasis HOTS. Pengambilan data dilakukan secara random sampling pada siswa kelas XI dan XII jurusan Matematika dan Ilmu Pengetahuan Alam Madrasah Aliyah Kabupaten Pati tahun ajaran 2020/2021. Berdasarkan hasil analisis data dapat disimpulkan bahwa kemampuan berpikir tingkat tinggi siswa Madrasah Aliyah di Kabupaten Pati berada pada kategori cukup baik. Hasil penelitian ini diharapkan dapat menjadi gambaran bagi para pelaku pendidikan di Kabupaten Pati khususnya untuk dapat melakukan perbaikan dalam proses belajar mengajar.

Kata kunci: biologi, kemampuan berpikir tingkat tinggi, siswa.

ABSTRACT

The challenges in the 21st century learning encourage educational institutions to produce young people who not only master in science but also have high-order thinking skills (HOTS). One way that can be taken to develop higher-order thinking skills is to provide HOTS-based exercises. Higher-order thinking skills are the ability to analyze, evaluate, and create information obtained to answer problems. The aim is to analyze the higher-order thinking skills of Madrasah Aliyah students in Pati regency on biology learning. This research is a type of quantitative research. The data was obtained by filling out the test instrument in multiple-choice form questions based on HOTS. Data collection was carried out by random sampling for XI and XII students majoring in Mathematics and Natural Sciences at Madrasah Aliyah in Pati Regency for the 2020/2021 academic year. Based on the results of data analysis, it can be concluded that the higher-order thinking skills of Madrasah Aliyah students in Pati Regency are in agood enough category. The results of this study are expected to be

an illustration for education actors in Pati Regency, particularly for making improvements in the teaching and learning process.

Keywords: biology, higher-order thinking skills, students.

A. INTRODUCTION

In order to face the challenges in the 21st century, educational institutions are required to make changes. It aims to prepare superior human resources who can adapt to various existing advances. The effort that can be done is to increase the higher-order thinking skills of students. Higher-order thinking skills (HOTS) are the ability to connect, manipulate, and change the knowledge and experience that already possesses critically and creatively in determining decisions to solve problems in new situations (Dinni, 2018).

By having high-level thinking skills, it is hoped that the younger generation in Indonesia will be able to play an active role in various fields. Motallebzadeh et al., (2018) argue that in 21st-century learning, students are not only required to understand the material but also have higher-order thinking skills (HOTS). According to Afflerbach et al., (2015), students who have high HOTS will be able to understand and criticize various problems in their environment.

The learning process is a series of activities between teachers and students with a reciprocal relationship that takes place in the teaching and learning process to achieve certain goals. According to Tajudin & Chinnappan (2016), a teacher is expected to be able to improve students' cognitive abilities from a low level to a higher level. The impact obtained from learning not only increases knowledge but also improves students' thinking skills. Hanifah (2019) stated that the function of implementing the HOTS questions is to measure students' ability to transfer between material concepts, process and apply the information they have, connect different information, criticize information, and develop solutions.

Based on the description above, this study aims to analyze quantitatively the higher-order thinking skills of students majoring on Mathematics and Natural Sciences at Madrasah Aliyah in Pati Regency,

period 2020/2021, in the learning biology. The results are expected to be the basis for designing teaching and learning activities in the future.

B. THEORITICAL REVIEW

Higher-order thinking skills are the ability to apply thought processes in complex situations with many variables. According to Brookhart (2010), cognitive processes in higher-order thinking skills include analyzing, evaluating, and creating. It can be interpreted through the ability to transfer knowledge, critical thinking skills, and problem-solving skills. According to Siddiq, all students can think, but most students need encouragement and guidance to have higher-order thinking skills. The purpose of HOTS-based learning is to improve students' thinking skills at a higher level. It is especially related to critical thinking skills in receiving various types of information, creative thinking in solving problems using their knowledge, and making decisions in complex situations (Erfan & Ratu, 2018).

However, the facts show that not all educational institutions can carry out the HOTS-based learning process well. In practice, the learning process is still oriented to students' cognitive understanding. Teachers tend to give recall evaluations and focus on theory (Arif, 2019). It also happens in the process of learning biology. The biology material is quite complex and the view that biology is a rote lesson causes students' thinking skills can not develop. Especially when students are familiarized with the types of theoretical evaluation questions. Indirectly it will affect the mindset of students.

In response to this, the learning process quality must be improved. According to (Lynch et al., 2019), thinking skills, scientific skills, and mastery of technology (Edwards, 2016) must be possessed by every student. Mitana et al. (2018) explained that efforts to improve the students' thinking skills can be done through the use of educational institutions. Training students to be able to think at higher levels means accustoming them to think critically and creatively for facing various problems. This can be demonstrated through the ability of students to apply their knowledge

and skills in various ways. Providing HOTS-based practice questions is one way that can be done to develop students' thinking skills (Dewi & Ichsan, 2018). In this case, the character of questions based on higher-order thinking skills is different from lower-order thinking skills. The presence of a stimulus in the form of statements, articles, pictures, tables, or graphs is a characteristic of HOTS-based questions. In the process of seeking and finding solutions or answers to these questions, students are required to think more deeply to analyze, evaluate, and create various information obtained. Wilson & Howitt (2018) argue that identifying causes, classifying important things, and making comparisons are the first steps that can be taken in solving HOTS questions. Brookhart (2010) explains that three things must be considered in the preparation of HOTS-oriented evaluation, namely using introductory material, using novelty material, and separately presenting cognitive complexity and difficulties.

Efforts to improve students' higher-order thinking skills are a long process. The right strategy and continuous effort are the keys to the success of this process. According to Yee et al. (2015), two important things must be considered in implementing the HOTS-based learning process, namely the quality of the learning itself and the teaching materials used. In this case, the learning process is seen as a complex activity. The teaching and learning process is not just a knowledge transfer activity but is a process of developing students' skills and mindsets. In addition, HOTS learning materials must also be considered. HOTS material should cover certain things but have broad material content.

C. METHODS

This study uses a quantitative approach. In practice, quantitative research will process and analyze numerical data obtained using statistics (Sugiyono, 2018). The quantitative data were obtained from filling in the instruments that were validated by the expert team in the form of questions. Besides, before being tested, the questions were analyzed for their level of validity, difference power, and level of difficulty. The targets of

this study were students majoring on Mathematics and Natural Sciences Madrasah Aliyah for the academic year 2020/2021 in Pati regency, with a research focus on the higher-order thinking skills (HOTS) of students in biology learning. The sampling technique was carried out through random sampling. Data analysis is based on indicators of higher-order thinking skills using the formula:

$$\text{Score} = \frac{Total\ score\ obtained}{Maximum\ score} \times 100$$

The resulting scores are converted into categories according to the following table.

Table 3.1. The categories of interpretation of higher-order thinking skills tests

Score	Category
81-100	Very good
61-80	Good
41-60	Good enough
21-40	Not good
0-20	Not very good

Source: (Arikunto, 2013)

D. DISCUSSION

The drafting of question instruments was based on the overall biology class X material. Basic competence (KD) of biology class X is composed of eleven KD (KD 3.1 - KD 3.11). Each KD is analyzed for the preparation of 5-6 questions. The form of questions was multiple choices with cognitive level C4-C6 and totaled 56 questions. Then the questions were tested on 50 students of class XI and XII to find out the validity, distinguishing power, and difficulty level of the questions.

Table 4.1. The results of the validity test, difference power, and difficulty level of the questions

Test	Value	Question number
Validity	Valid	2,3,4,5,6,7,8,10,11,14,15,16,17,18,19,20,21,22,23,24,28,29,30, 31,36,37,38, 39,40,41,42,44,45,46,47,48,49,52,53,54,55
	Invalid	1,9,12,13,25,26,27,32,33,34,35,43,50,52,56
Diffrence power	Good	2,3,4,5,6,7,8,14,15,16,17,18,19,20,21,22,23,26,27,28,30,36,39, 41,44,45,46,47,48,50
	Enough	24,25,29,31,32,37,38,40,42,43,51,53,54
	Bad	1,9,10,11,12,13,33,34,35,49,52,55,56
Difficulty level	Difficult	2,3,4,5,6,7,8,10,11,14,15,16,17,18,20,21,22,23,36,41,11,45,46, 47,48,53,54,55,56
	Moderate	1,9,12,13,19,24,25,26,27,28,29,30,31,32,33,34,35,37,38,39,40, 43,49,50,51,52
	Easy	42

The question instrument was then validated by a team of experts so that 24 items were used to measure the students' HOTS. The basis for selecting these items is a valid one, has sufficient or good distinction power, moderate or difficult level, and represents each KD. Furthermore, 24 selected questions were tested on 214 Madrasah Aliyah students in Pati regency. The results of the student's HOTS test analysis showed that the average value obtained was 46.55. The details of student test results can be seen in the following tables.

Table 4.2. The results of student score analysis

Statistic	Score
Maximum	92
Minimum	12
Mean	46,55
St. dev	2,28

Table 4.3. Categories for testing students' higher-order thinking skills

Score	Category	Frequency
81-100	Very good	4
61-80	Good	43
41-60	Good enough	87
21-40	Not so good	60
0-20	Not very good	20

Based on the analysis of the data obtained, the high-level thinking skills of Madrasah Aliyah students in Pati regency are in a good enough category. This was also stated by Prasetyani et al., (2016), Kurniati et al., (2016), and Saraswati & Agustika, (2020) who stated that most students had high-order thinking skills at a sufficient level.

Students' higher-order thinking skills are influenced by several things, including the literacy skills possessed by students. The interview result showed that some students tended to be confused and lazy to read the questions because the test questions were presented with a stimulus in the form of long readings, graphics, or complex pictures. Students also have difficulty in interpreting pictures, graphs, or tables that are presented as a stimulus to the questions. According to Rahayuni (2016) and Ristanto et al. (2018), the ability to interpret can be grown through the process of reading habituation and reading analysis.

The results of Dinni's research (2018); Susiati et al. (2018); and Susiati et al. (2018) show that higher-order thinking skills are related to

someone's literacy ability. Sujana et al. (2014) explained that literacy is the result of a process of formal education and interaction with the community continuously. Literacy skills can be used to identify the understanding of science material concepts and teachers' science process skills (Rubini et al., 2018).

In addition, the lack of implementation of HOTS-based learning also affects the level of higher-order thinking skills in students. When students have never participated in HOTS-oriented learning, students tend not to be able to develop higher-order thinking skills. According to Sari et al. (2019) and (Mayasari & Adawiyah (2015), there is a significant relationship between HOTS and implementation in the learning process.

According to Anderson & Krathwoll (2001), the dimensions of cognitive processes are divided into 6 levels, namely remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6). The higher-order thinking ability is the highest cognitive domain in Bloom's taxonomy, which is composed of several levels, namely analyzing, evaluating, and creating (Tanujaya et al., 2017). The analyzing ability (C4) is the ability to sort, explain, differentiate and obtain something (Darwazeh & Branch, 2015). The evaluating ability is the ability to assess something according to predetermined criteria or standards (Krathwohl, 2002). Ramos et al., (2018) add that evaluation is the ability to express and defend an opinion. According to Anderson et al. (2001), the creating ability is the ability to formulate hypotheses, plan and create something. The following is a table of analysis of high-order thinking skills of students:

Tabel 4. 4 Percentage analysis of students' higher order thinking skills

Dimensions of Cognitive Process	Total Score	Percentage (%)
Analyze (C4)	1009	43,14
Evaluate (C5)	681	29,11
Create (C6)	649	27,75

Based on Table 4.4, it can be concluded that the dimensions of cognitive processes that are most mastered by students are at the level of analyzing, then evaluating, and finally creating. Creating is the highest ability at the level of the cognitive process dimension. Brookhart (2010) explains that higher-order thinking skills include learning for recall and transfer the information, critical thinking skills, and problem-solving skills. Brookhart's opinion is then used as a reference to develop higher-order thinking indicators. The percentage analysis of the cognitive process dimension indicators can be seen in Table 4.5.

Tabel 4. 5 Percentage analysis of student cognitive process dimension indicators

Dimensions of Cognitive Process	Indicator	Percentage (%)
Analyze (C4)	Able to provide attributes based on the analysis process	25,97
	Able to conclude	25,57
	Able to connect various information	25,07
	Able to sort components	23,39
Evaluate (C5)	Able to decide or determine	25,11
	Able to validate information	25,99
	Able to predict	29,96
	Able to describe a concept	18,94
Create (C6)	Able to design or plan	18,49
	Able to combine various information	28,20
	Able to compile various information	21,41
	Able to make solutions	31,90

Based on the results, the indicator which has the largest percentage of creative ability is being able to make solutions (31.90%). The next largest percentage can combine various information obtained (28.20%), then able to compile various information obtained (21.41%), and the smallest percentage is the indicator of being able to design or plan

(18.49%). The high acquisition of indicators can make the solution influenced by the selection of the right stimulus (related to the surrounding environmental conditions) so that students can analyze the questions well. Fanani (2018) explains that the use of contextual and interesting stimuli is the basis for making HOTS questions so that in this case teacher creativity is needed.

According to Prasetyani et al. (2016), the ability to create includes the ability to analyze problems correctly, choose appropriate initial ideas, and explain the right reasons. Gunawan & Palupi (2012) explain that generalizing and producing are the two main abilities at the level of creating (C6). The ability to think divergently relates to the ability to generalize, while the ability to produce refers to the ability to develop a solution to a problem.

In the ability to evaluate (C5), the indicator capable of predicting an event has the largest percentage, which is 29.96%. Furthermore, the indicator of validating information capability is 25.99%, deciding ability at 25.11%, and describing a concept at 18.94%. According to Nurhayati & Angraeni (2017), the evaluating ability begins with the planning process, implementing the plan, understanding the content of the question, and giving the right reasons. So one of the requirements to have the ability to evaluate (C5) is to have good literacy skills. It aims to be able to understand the content of the question correctly. The low percentage of describing a concept is influenced by the low literacy ability of students. Students can not understand the stimulus in the form of complex images or graphics. Syofyan et al. (2019) argue that literacy skills should be developed in a structured and consistent activity in the learning process.

The results showed that at the analyzing level (C4), the indicator capable of providing attributes based on the analysis process had the biggest percentage value of 25.97%, then able to conclude at 25.57%, able to relate various information at 25.07%, and able to sort out the components at 23.39%. According to Gunawan & Palupi (2012), the ability to provide attributes can be improved through problem-based learning.

The existence of a problem leads to identifying important and relevant things, then organizing or connecting them.

E. CONCLUSION

Higher-order thinking skills (HOTS) include the ability to analyze (C4), evaluate (C5), and create (C6). Based on the results, it can be concluded that the higher-order thinking skills of Madrasah Aliyah students in Pati regency are in a good enough category. Several factors that can affect students' HOTS include the students' literacy skills, the teaching method, and the learning tools. So it is necessary to have further research related to the knowledge and teachers' skills to develop HOTS in the biology learning process. By knowing the description of HOTS abilities in teachers and their implementation in the teaching and learning process, it is hoped that it can be an input for designing a more effective learning process. So that the goal of increasing higher order thinking skills in students can be realized properly.

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