



Analysis of Knowledge, Higher-Order Thinking Skills, and Compiling Evaluations for MA Biology Teachers in Pati Regency

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Article Info	Abstract
Article History : Received September 2021 Accepted December 2021 Published April 2022	The thing that biology teachers must pay attention to in educating students to be able to think at higher-order is the mastery of the teachers' knowledge in biology material, the teachers' higher-order thinking skills, and their ability to develop HOTS in the learning process. When the teachers possess them, the teacher can create and develop an effective HOTS learning class. The purpose of this study was to analysis the ability of knowledge (factual, conceptual, procedural, and metacognitive), higher-order thinking (analyzing, evaluating, and creating), and activities to design HOTS-oriented evaluations for Madrasah Aliyah teachers in Pati Regency. This study uses a mixed-method approach with a sequential explanation method. The research population includes members of the MA (high school level) Biology MGMP (Biology Subject Teacher Conference) in Pati Regency, totaling 35 people. The results showed that 1) MA teachers in Pati Regency had high-level knowledge and thinking skills in ecosystem concepts in the sufficient category, and 2) the ability to compile a HOTS-oriented biology learning evaluation was in a good category.
Keywords: biology, higher-order thinking skills, HOTS-oriented evaluation, knowledge dimension, teacher	

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INTRODUCTION

High-order thinking skills (HOTS) are things that must be owned by every education actor, both teachers and students during the industrial revolution 4.0. This is due to the increasing demands for the quality of graduates from an educational institution. HOTS refers to a person's ability to absorb information, ideas, or opinions (Smetanová et al., 2015), analyse them (Rodzalan & Saat, 2015), then process them to produce an innovation to solve existing problems (Nailya et al., 2015). Husamah et al. (2018) added that there are three aspects to HOTS, namely critical, creative and independent thinking skills. These three aspects are interconnected and form a unity. If someone has good independent thinking skills, his critical and creative thinking skills are also good.

Biology is often identified with rote subjects. This causes in practice, it is often found that there are many biology learning processes that only focus on understanding theory and use theoretical biological evaluation. This of course will cause students to be unable to think critically and creatively (high-order thinking) because the abilities that students have are a description of the abilities possessed by their teachers. According to Tan & Halili (2015), the role of teachers in instilling HOTS in students is an important aspect of an effective HOTS-oriented learning process. The results of research by Retnawati, et al. (2018) show that teachers have understood the importance of HOTS and have carried out various innovative learning models, but their ability to increase and measure the students' HOTS is still low. Ramdiah et al., (2019) added that the teachers had designed learning well, but this was not done continuously and ignored the HOTS aspect. This can be due to the fact that teachers do not have sufficient understanding regarding the application of HOTS (Sukmawati et al., 2019), do not understand learning plans and HOTS-oriented assessment techniques (Yusuf et al., 2018), never apply HOTS-oriented learning (Awaliyah, 2018), only focuses on the mastery of material concepts, and less trained in designing learning (Anggraeni, 2009).

So that many factors must be analysed. One of them is the teachers' ability to provide HOTS-based learning. Teachers play an important role in instilling higher-order thinking of students in an

effective learning process (Tan & Halili, 2015; Richland & Begolli, 2016). Hashim et al. (2015) explain that everything that the teacher believes and has attempted by the teacher in a learning process will have an impact on student achievement. In other words, there is a change in an educational process depending on the mind-set and actions taken by the teachers. In addition, things that must be considered in educating students to be able to think at higher levels are the teacher's knowledge of biology, higher-order thinking skills in teachers, and the skills of teachers in developing HOTS in learning process. The topic that is taken to measure the level of understanding of biological concepts in teachers is the ecosystem. This is based on the results of a questionnaire on the selection of biology material which has a moderate-high level of difficulty according to several teachers. The results of the questionnaire show that the ecosystem has the largest percentage compared to other materials, namely 17%.

Facts in the field show that some teachers have an inaccurate understanding of the HOTS concept. In the results of Miarsyah & Ristanto's (2019) research, it was stated that some teachers had missed concepts in understanding HOTS-based questions. They think that HOTS questions must have a high level of difficulty. Even though the essence of HOTS questions and difficult questions are different. When facts like this are found, of course, the goal of a learning process to be able to improve higher-order thinking skills in students is difficult to achieve.

Based on the description above, the researcher aims to analyse the knowledge, higher-order thinking skills, and the ability to design HOTS-oriented evaluations for Madrasah Aliyah teachers in Pati Regency. This is because there is no research to analyse higher-order thinking skills and the ability to design HOTS-based evaluations for MA biology teachers in Pati Regency. The results of the research are expected to become a reflection for educational actors, especially biology teachers.

METHODS

This study uses a mixed-method approach with a sequential explanation method. The sequential explanation method begins with the use of quantitative methods followed by qualitative

methods and then ends with interpretation. In the first stage, this research uses a non-experimental quantitative approach with a cross-sectional survey method, while in the second stage, it uses the case study method (one case study). The choice of this method aims to be able to produce more comprehensive and in-depth data about the thinking skills of MA biology teachers in Pati Regency.

The population in this study were all active members of the MA Biology MGMP in Pati Regency in the academic year 2020/2021, totalling 35 people. Because the population is relatively small, the researchers used a total sampling technique in this study. The variables used in this study were the level of knowledge, higher-order thinking skills (HOTS), and the ability of teachers to design HOTS-oriented evaluation in biology learning.

Data collection techniques related to the level of knowledge and higher-order thinking skills were carried out using a test technique by giving 20 multiple-choice questions to biology teachers. The test instrument testing included validity, differentiation, and difficulty levels using Excel Microsoft. Meanwhile, data collection related to the teacher's ability in designing HOTS-oriented biology learning evaluations was carried out using interview and observation techniques. Interview and observation techniques are also used to confirm or evaluate the obtained test data.

The data analysis technique is done by giving a score on the teacher's answer or the result of the observation. If the answer or observation result is correct, the teacher get a score of 1, whereas if the answer or observation result is wrong, the teacher get a score of 0. The total score obtained is then calculated by the formula:

$$\text{Score} = \frac{\text{The number of scores obtained}}{\text{Maximum score}} \times 100$$

The value obtained is then qualified according to the Table 1.

Table 1. Qualifications of Higher-Level Thinking Abilities

Score	Category
76 - 100	Very good
51 - 75	Good
25 - 50	Good enough
0 - 25	Not good

RESULTS AND DISCUSSION

Question Instrument Testing

The instrument test aims to determine the level of validity of the questions that have been compiled. In this study, the validity test was conducted in two ways, namely rational validity (logical analysis) and empirical validity (empirical analysis). Rational validity is obtained based on the results of logical thinking by experts. After testing the rational validity, the question instrument which is composed of 40 item questions is then corrected according to the suggestions.

The empirical validity test was carried out by being tested on students of the Postgraduate Science Department of Universitas Negeri Semarang. The respondents who participated in this test were 32 students. This test includes the validity test, level of differentiation, and level of difficulty of the question items. The conclusion of the empirical validity test results is presented in the following Table 2.

Table 2. Results of the Instrument Empirical Test.

Test	Item Number
Validity	Valid: 3, 4, 5, 6, 8, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, 30, 31, 32, 33, 34, 37, 38, 39, 40 (32 items) Invalid: 1, 2, 7, 11, 12, 27, 35, 36 (8 items)
Level of Differentiation	Good: 3, 5, 6, 8, 10, 13, 16, 18, 19, 22, 23, 24, 25, 27, 29, 30, 32, 33, 34, 38 (20 items) Enough: 7, 9, 12, 14, 15, 17, 20, 21, 26, 31, 36, 37, 39, 40 (14 items) Weak: 1, 2, 4, 11, 28, 35 (6 items)
Level of Difficulty	Difficult: 11, 14, 35 (3 items) Medium: 1, 2, 3, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 31, 32, 33, 34, 36, 37, 39, 40 (34 items) Easy : 4, 30, 38 (3 items)

Knowledge Ability Analysis

Knowledge is one of the areas of assessment in a learning process. Research on 35 teacher members of the Madrasah Aliyah MGMP in Pati Regency showed that the ability of teachers' knowledge in ecosystems concept was in enough category. This is based on the acquisition of an average score of 44.9. The table below details the percentage of teachers' knowledgeability categories.

Table 3. The Teachers' Knowledge Ability Category

Category	Number of Respondents	Percentage
Very good	0	0
Good	9	25.7
Good enough	25	71.4
Not good	1	2.9

The case that influenced the findings was the teacher's low interest in reading. The teachers prefer short questions to questions that have a variety of stimuli. Based on the interview, the teacher stated that they tended to skim the stimulus and focused more on the question sentences and answer choices. This action will affect the accuracy of the selected answer. The interview result also shows that teachers are not accustomed to reading activities (to increase knowledge) due to various reasons for their respective activities. The research results by Wahyuni et al. (2017) showed that the reading interest of prospective teachers was in a low category. Reading interest in prospective teachers is influenced by their intelligence level (Mayasari & Adawiyah, 2015). According to Ayu et al. (2018), reading is the basis for acquiring, processing, and managing scientific knowledge. Periyeti (2017) argues that reading activities can update knowledge continuously.

The low reading interest of teachers can also be seen from the handbooks used in the biology learning process. Teachers tend to use only one worksheet in the learning process rather than using a variety of biology textbooks. It will certainly affect the knowledgeability possessed by the teachers themselves. Malawi (2016) explains that teachers need to search for information from various sources to be able to improve competence and support effective learning. The results of research by Suryawati et al. (2018) show that teachers have not

provided varied learning materials in the teaching and learning process.

The results of the analysis show that the dominance of the teacher's knowledgeability is in the metacognitive dimension. The top achievement on the knowledge dimension according to Bloom's revised taxonomy is metacognitive knowledge. Indarini et al. (2013) argue that metacognitive knowledge should be the main focus in the learning process in Indonesia. Solihat et al. (2018) explain that one of the focuses in metacognitive knowledge is strategic knowledge, namely strategies in learning and strategies in solving a problem. The indicator of having the metacognitive ability is being able to reconstruct various information obtained by involving intellectual, emotional, and spiritual aspects (Jayendra, 2018). Based on this opinion, it can be concluded that teachers have been able to regulate cognitive abilities and reflect on the information obtained to create something. The analysis of the dimensions of knowledge obtained are as follows:

Table 4. The Teachers' Knowledge Ability Percentage Analysis

Knowledge Dimension	Total Score	Percentage
Factual	114	29.0
Conceptual	70	17.8
Procedural	84	21.4
Metacognitive	125	31.8

Higher-Order Thinking Skills Analysis

Based on the analysis of results, it is known that the higher-order thinking ability (HOTS) of the MA biology teachers in Pati Regency towards the ecosystem concept is in the sufficient category. The conclusion is taken based on the acquisition of an average score of 44.9. The results of the teacher HOTS analysis show that there are 9 teachers who are in the good category (25.7%), 25 teachers are included in the fairly good category (71.4%), and 1 teacher is included in the poor category (2.9%).

The low acquisition of higher-order thinking skills in teachers is thought to be influenced by several things, including the lack of teachers' literacy skills. This is in accordance with the findings of Pahrudin et al. (2019) which states that the teachers' literacy ability is still in the poor category and must be improved. Dinni (2018); Susiati et al. (2018); and

Hikmah et al. (2019) states that higher-order thinking skills are related to a person's literacy ability. Rubini et al. (2016) explained that literacy skills can be used to identify the understanding of science material concepts and teachers' science process skills. The results of the interviews showed that there were some teachers who 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. Not being used to working on web-based questions is also one of the reasons why teachers cannot answer questions well. Teachers tend to feel comfortable working on paper-based questions. Some teachers reasoned that the age factor was the cause of it.

In addition, the lack of implementation of HOTS-based learning also affects the low level of higher-order thinking skills in teachers. When the teacher never uses the HOTS approach in the learning process, the teacher tends not to develop their higher-order thinking skills. It is in line with the research results of Sari et al. (2019) which shows that there is a significant relationship between HOTS and its implementation in the learning process.

Mastery of concepts is also suspected to affect higher-order thinking skills in teachers. When the teacher understands the material concept broadly, the teacher can analyse the material better. Lestari et al. (2017) state that mastery of the material can affect critical thinking skills. Ramdani et al. (2020) add that critical thinking ability can only be done by knowledge. The details of the teacher HOTS categories are presented in the following Table 5.

Table 5. HOT Teachers Category

Category	Number of Respondents	Percentage
Very good	0	0
Good	9	25.7
Good enough	25	71.4
Not good	1	2.9

Based on the research, it can be concluded that the dimensions of cognitive processes that are dominated by the teachers are evaluating, analysing, 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 the ability to recall the knowledge

possessed and transfer it, think critically, and solve the problem. Brookhart's opinion is used as a reference to develop higher-order thinking indicators. The following is a table of higher-order thinking skills analysis of MA biology teachers in Pati Regency on the ecosystem concept.

Table 6. Analysis of Percentage of High-Order Thinking Skills for MA Biology Teachers in Pati Regency on Ecosystem Concept

Cognitive Process Dimensions	Total Score	Percentage
Analyse (C4)	156	39.7
Evaluate (C5)	166	42.2
Create (C6)	71	18.1

Analysis of Ability to Arrange HOTS-Oriented Evaluations

Evaluation is an ongoing action or process to provide "value" in order to measure students' abilities or knowledge. This is done in order to know the progress of students (Kumar et al., 2016). Based on the results of the study, the teachers' ability in compiling a HOTS-oriented biology evaluation was included in the capable category with an average score of 52.9. The same thing was stated by Yayuk et al. (2019). The results of their research indicate that teachers are skilled and understand the techniques or methods of developing and compiling HOTS-based assessments. These findings are slightly different from the findings of Arti and Hariyatmi (2015) and Iskandar and Gymnastics (2015) which state that teachers have not been able to prepare HOTS questions properly. The results of Rapih and Sutaryadi (2018) also show that teachers still find many difficulties in preparing HOTS-oriented questions.

The analysis show that the teachers have compiled various questions and provided a stimulus, either in the form of pictures, tables, or stories. In addition, the teachers also compiled questions with contextual material. It is intended that students have dynamic and flexible knowledge and skills to actively construct their understanding. Another important finding is that teachers have managed cognitive complexity and difficulty separately. It means that the teacher does not associate the complexity of the material with the cognitive level of the question. On the other hand, the ability of teachers to arrange the problem-based questions is

still low. This can be seen from the lack of problem-based questions compiled by the teachers. In addition, the teacher also does not compile a grid of questions and assessment guidelines. Even though at the time of the interview the teachers stated that they compiled a grid of questions and assessment guidelines in the evaluation questions arrangement.

The character of HOTS-based questions includes measuring higher-order thinking skills, using various types of questions, using contextual stimuli, and using problem-based questions (Widodo & Kadarwati, 2013; Nugraha & Mahmudi, 2015; Jailani, et al., 2017; Kristiyono, 2018; Rohim, 2019; Sukmawati et al., 2019 and Ichsan, et al., 2020). The use of problem-based questions can increase analytical and evaluative thinking skills (Mayasari & Adawiyah, 2015). Wakhidah (2018) adds that being able to create rational solutions is one indicator of increasing thinking skills. The following table is a summary of the category analysis of teacher abilities in compiling HOTS-based learning evaluations.

Table 7. Summary of the Ability Category Analysis Compiling Evaluations

Category	Respondent
Very Good	6, 16, 17, 26, 32
Good	2, 7, 8, 10, 12, 13, 23, 25, 29, 34
Good	1, 4, 5, 11, 15, 18, 19, 21, 24, 27,
Enough	28, 30, 31, 33, 35
Not Good	3, 9, 14, 20, 22

Based on the results of observations, the teachers' ability in compiling evaluations of HOTS-oriented biology learning is influenced by several things, including the length of teaching, education, understanding of the HOTS concept, and the implementation of HOTS in the learning process. It can be seen from the respondents who have a very good category in compiling HOTS-based evaluations are teachers who have been teaching for a long time (13-31 years) and have an educator certificate. Teaching time greatly affects the teachers' ability in preparing evaluations, because the teachers who have been teaching for a long time will have experience in compiling evaluations with more frequency. Especially when the teachers have sufficient knowledge and skills in preparing a good learning evaluation (as evidenced by the existence of an educator certificate). The results of research by

Ramdani et al. (2019) show that the low ability of teachers in compiling HOTS-oriented questions caused by the teachers have not been trained to develop questions with higher-order thinking categories.

In addition, majors in the teachers' last education also affect the ability to prepare evaluations for teachers. It is known that teachers who have excellent evaluation skills are teachers who graduated from the department of biology education. It is in line with the findings which show that there are teachers who have good thinking skills but can compile sufficient evaluations (Respondent 5). Observation results indicate that the teacher is not a graduate of biology education. According to Anwar et al. (2012) and Rubini et al. (2018), the teachers' skills in carrying out the learning process are influenced by the teachers' educational background. The results of Bahri's research (2019) show that there are 102 out of 366 teachers whose educational backgrounds are not following the expertise. The influencing factors are knowledge, skills, motivation, attitudes, responsibilities, and teaching experience.

The correct understanding of the HOTS concept also affects the ability to prepare HOTS-oriented evaluations for teachers. The results of the interview showed that the majority of teachers had never attended a seminar or training related to HOTS. Teachers get HOTS knowledge from the process of reading from the internet, understanding examples of HOTS questions in the handbook, and discussions with others. Research by Wahyuningtyas and Ratnawati (2018) and Safi'i and Amar (2019) shows that training in the arranging of HOTS questions can improve the ability of teachers to design HOTS-based questions. The results of the interview also showed that there was a missed concept related to the HOTS criteria in the teachers' minds. Some teachers argue that HOTS questions should be difficult questions. Safi'i and Amar (2019) explained that HOTS questions must be able to stimulate logical, creative, and systematic thinking.

Setiawan et al. (2019) explain that the preparation of HOTS questions can be done using two approaches, namely based on KD (Basic Competence) and based on the level of the question. Based on the KD approach, HOTS questions can only be done on materials with KD that lead to the process of analysing (C4), evaluating (C5), or

creating (C6). Meanwhile, based on the level of questions, HOTS questions can be arranged at any KD level. Even though KD is at C1, C2, or C3 level, the HOTS questions can be prepared on the condition that the questions fall into the HOTS criteria. The obstacles faced by teachers in compiling the HOTS-based evaluation are 1) teachers do not understand the concept of HOTS questions well, 2) teachers' literacy skills are still low, 3) lack of references, 4) limited time, 5) teachers have not been able to arrange the stimulus questions well, 6) teachers are not used to conducting HOTS-based biology learning, and 7) lack of guidance and supervision by related parties. It is following the results of Purwasih's research (2020) which shows that the obstacles faced by prospective teachers in compiling HOTS-based multiple-choice questions are how to arrange the stimulus, lack of understanding of teaching materials, lack of mastery of the application of Bloom's taxonomy, insufficient time, and lack of the lecturer's explanation. Kiswara et al. (2019) and Anggraeni and Sole (2020) add that the obstacles faced by teachers in implementing HOTS-based learning are the low understanding of teachers regarding the concept and application of HOTS, the lack of teacher ability in formulating HOTS-based questions and assessments, and the lack of learning facilities and infrastructure. According to Sukmawati et al. (2019), the things that must be considered in compiling HOTS questions are mastery of teaching materials, writing questions skills, and creativity in the use of stimuli.

CONCLUSION

Based on the results of the research, it was found that the biology teachers at Madrasah Aliyah in Pati Regency had the knowledge and higher-order thinking skills in ecosystem concept at a good enough category, besides the ability to compile a HOTS-oriented evaluation is at a good category.

Responding to these findings, it is advisable to hold seminars or training related to HOTS which can be attended by all teachers who are members of the MA biology MGMP in Pati Regency, give supervision and guidance from related parties regarding the implementation of HOTS in learning process, and efforts to increase literacy skills to support HOTS abilities of teachers themselves.

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