

## HIGHER-ORDER THINKING SKILL (HOTS) ANALYSIS OF GRADE IX STUDENTS ON BIOTECHNOLOGY MATERIALS

Fifty Octavia Astuti, Aa Juhanda, Suhendar

*Pendidikan Biologi Universitas Muhammadiyah Sukabumi, Jl.R. Syamsudin SH No.50 Sukabumi,*

\*Corresponding author: [fiftyocha15@gmail.com](mailto:fiftyocha15@gmail.com)

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### ABSTRACT

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Higher Order Thinking Skills (HOTS) are substantial abilities that students must have as a basis for complex thinking skills. This study aims to determine the Higher Order Thinking Skills (HOTS) of eighth-grade students on biotechnology material. The research method used is qualitative. The population in this study were students at one of the boarding schools in the Sukabumi district. The research sample consisted of 24 students. The instrument used was multiple-choice test questions with four choice options. The questions used in this study have a reliability of 0.7 (sufficient) and validity of 0.8 (high). The research data showed that the students' HOTS ability was still low. The t-test results, which compared the students' acquisition scores with the completeness score (60), obtained a sig value of 0.78, meaning that there was no difference in the mastery score and the HOTS acquisition of students. Calculation data based on cognitive level categories, learning indicators, and achievement categories also show that the HOTS ability of students is still low.

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## INTRODUCTION

The development of the current era allows all educators and students to get information freely, quickly, and efficiently. Science and technology today have become one thing that plays a vital role in this life. Educators have a position to improve the intelligence and welfare of all students, in terms of spiritual and intellectual. Science education has great potential to play a strategic role in preparing human resources in the face of the industrial revolution 4.0 era. Education must also be oriented to produce superior human resources (Human Resources). Excellent human resources are lifelong students who have global competence and behave under the values of Pancasila ([Kemendikbud, 2019](#); [Kemendikbud, 2020](#)). This can be realized if students can think logically, are critical, creative, initiative, and adaptive.

Higher-order thinking is one of the important abilities for students ([Prasetyani, et al., 2016](#); [Chotimah & Nurdiansyah, 2017](#); [Kurniasih, Nugroho & Harmianto, 2020](#); [Pantas, et al., 2020](#)). It is crucial for students to master higher-order thinking skills because, with these abilities, students can be motivated and always look at every problem critically and try to solve it creatively. This ability will also be the basis for obtaining other abilities such as creativity, critical thinking, and problem-solving skills ([Amri. R.F., 2016](#); [Marniwati, 2019](#); [Muspawi, et al., 2019](#)).

Developing thinking skills must continue to be done because it can form individuals who successfully face all challenges. A person's ability to succeed in life is determined, among other things, by his thinking ability, especially in solving the problems he faces. Therefore, one of the thinking skills that students must possess is higher-order thinking skills. The thought process is a process that a person carries out in recalling the knowledge that has been stored in his memory for a time to be used in receiving information, processing, and concluding something ([Widyastuti, 2015](#)).

Teachers need to know the HOTS of students as a basis for teachers to design or design learning experiences. Teachers must design learning experiences that can train and provide HOTS to students. So that research on HOTS profile analysis is important because it can provide an overview of HOTS mastery by students. This information can provide input and recommendations for teachers related to teachers' strategies in carrying out learning activities.

## RESEARCH METHOD

This study aims to determine the HOTS of grade IX students in biotechnology. The population used was students at one of the boarding schools in Sukabumi for the 2020/2021 school year. The sample used was 24 students, based on the purposive sampling technique, based on the research objectives. The method used in this research is the quantitative method. This research was carried out on March 24, 2020. Data collection used an essay test instrument with as many as 19 questions. The question has been tested through the Latest application. The results obtained are reliability 0.81, standard deviation 5.10, and correlation 0.71 using three HOTS indicators according to Anderson and Krathwohl (2001), namely analyzing, evaluating, and creating (Table 1). The HOTS indicator was developed based on the dimensions of cognitive processes of analysis, evaluation, and creation (Table 2).

Table 1. List of Learning Indicators on Biotechnology Materials

No	Learning indicators
1	Students analyze the principles of conventional and modern biotechnology
2	Distinguish between simple biotechnology and modern biotechnology
3	Analyzing the sources of biotechnological agents and the resulting products
4	Analyze the principles of genetic engineering and its products
5	Analyzing the role of biotechnology in various fields
6	Doing a simple mini research applying the principle of fermentation in making donuts
7	Analyzing the relevance of the verses of the Qur'an and Hadith with biotechnology

Table 2. List of Learning Indicators on Biotechnology Materials

No	HOTS	Description
1	C4 (analyzing)	Students can specify related aspects to be able to criticize
2	C5 (evaluating)	Students can make their own decisions to choose the type of choice that is more profitable if selected
3	C6 (creating)	Students can create their ideas to design a different form

The scores obtained are then analyzed based on the achievement of each learning indicator, cognitive level, and achievement category according to [Arikunto \(2012\)](#) namely very good criteria (80-100%), good criteria (66-79%), sufficient criteria (56-65%), less criteria (40-55%) and very less criteria (<40%). The data obtained were also analyzed by parametric statistics to determine the HOTS score obtained compared to the class completeness score (60).

## RESULT AND DISCUSSION

The research data is presented in simple statistical results based on the categories of learning indicators, cognitive levels, and achievement categories ([Arikunto, 2012](#)). In addition, a t-test parametric statistical test was conducted to determine the difference between the scores obtained by students and the completeness scores.

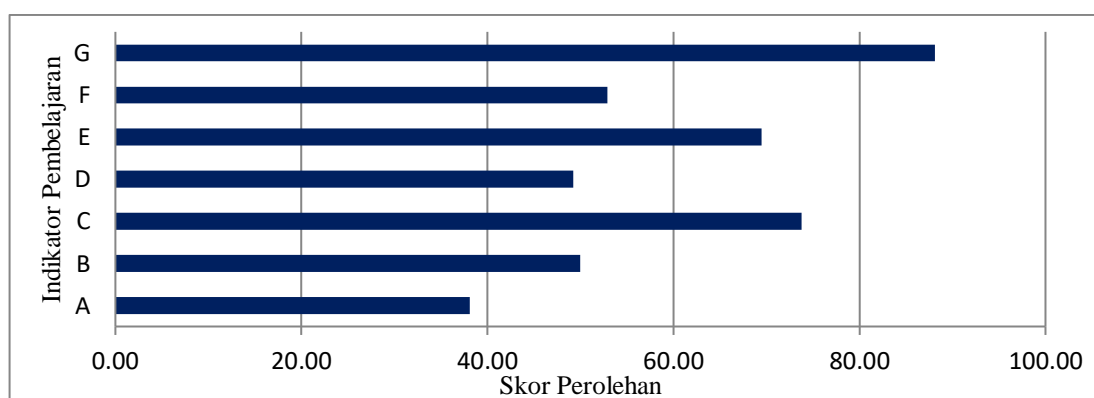
Table 3.t-test result

Test Value = 60					
95% Confidence Interval of the Difference					
t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
0,284	20	0,780	1,402	-8,91	11,72

The results of the t-test indicate that the HOTS scores of students are not significantly different from the completeness scores (60). This indicates that the students' HOTS scores still need to be improved.

Obtaining a score on each indicator also shows that students' HOTS abilities still need to be improved from 7 learning indicators, only three learning indicators whose acquisition is above the mastery number. Indicators whose scores are above the completeness score: (C) Analyzing the sources of biotechnological agents and products produced; (E) Analyzing the role of biotechnology in various fields and (G) Analyzing the linkage of the verses of the Qur'an and Hadith with biotechnology. Meanwhile, other learning indicators are still below the completeness score (Figure 1).

Based on the category of cognitive process dimensions of HOTS achievement, students can be categorized into analyzing, evaluating, and creating. Figure 2 shows the students' HOTS achievement in each category of cognitive process dimensions proses.



**Gambar 1.** Obtaining HOTS Scores on Each Learning Indicator: (A) Students analyze the principles of conventional and modern biotechnology; (B) Distinguish between simple biotechnology and modern biotechnology; (C) Analyzing the sources of biotechnological agents and the resulting products; (D) Analyzing the principles of genetic engineering and its products; (E) Analyzing the role of biotechnology in various fields; (F) Conducting simple mini-research applying the principle of fermentation in making donuts; and (G) Analyzing the relevance of the verses of the Qur'an and Hadith with biotechnology.

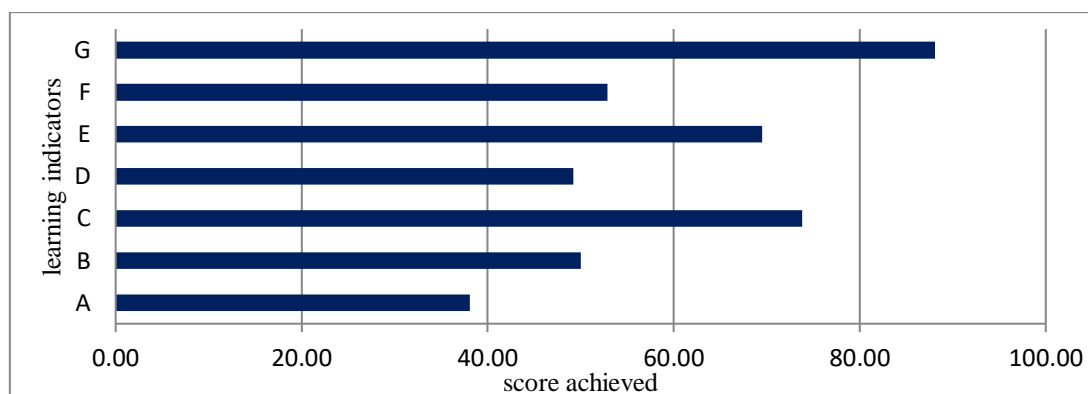


Figure 2. Obtaining HOTS Scores on Each Cognitive Process Dimension Indicator

Based on the category of achievement according to [Arikunto \(2012\)](#) the achievement of the HOTS of students can be categorized into categories of very good, good, sufficient, less, and very less (figure 3).

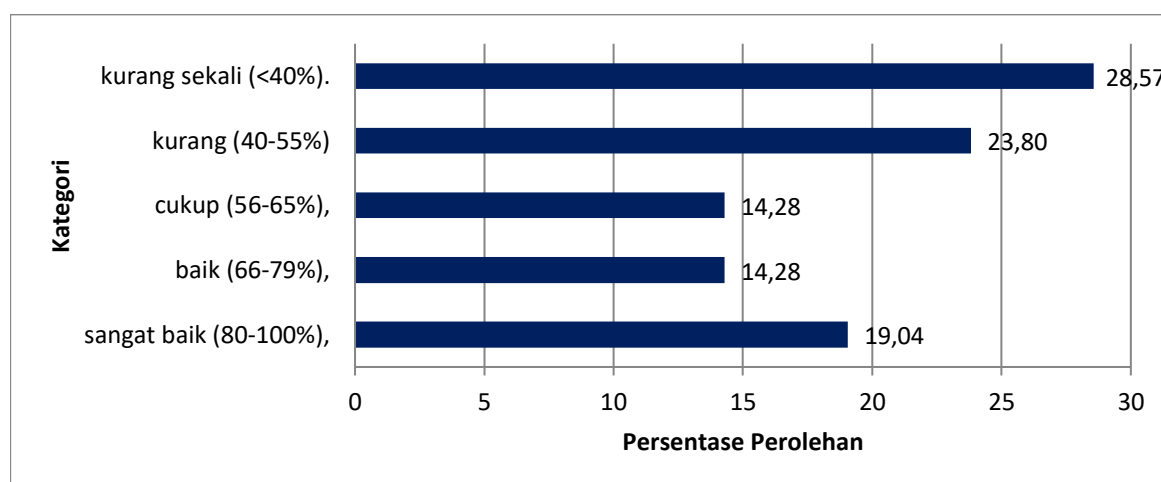


Figure 3. Graph of Student Percentage by Achievement Category [Arikunto \(2012\)](#)

Figure 3 shows that the percentage of achievement in the category is significantly less and less than the other categories. Only 19% of students achieved the very good category, and 14% achieved the good category. This shows that the HOTS of students still needs to be improved.

The results showed that those categorized based on learning indicators, cognitive levels, and achievement categories showed that students' HOTS achievement still needed improvement. The achievement of the HOTS scores of these students indeed cannot be separated from the experience or learning strategies carried out by the teacher. The learning experience experienced by students will affect students' HOTS abilities ([Setiono, et al., 2020](#); [Shukla & Dungsungnoen, 2016](#); [Saïdo et al., 2020](#)). If the teacher conditions tasks or activities that train HOTS, students will experience analyzing, evaluating, and creating. This experience will increase students' HOTS. On the

other hand, if HOTS is not trained, this ability will not be possessed by students ([Andriyani, & Saputra, 2020](#); [Heong, et al., 2012](#)).

The results showed that the HOTS ability of students still needed to be improved. The score results are calculated based on indicators and based on cognitive processes. The average score on each indicator shows four indicators whose achievements are still below the KKM. The four indicators are: A) Students analyze the principles of conventional and modern biotechnology; B) Distinguish between simple biotechnology and modern biotechnology; D) Analyzing the principles of genetic engineering and its products and F) Conducting simple mini-research applying the principle of fermentation in making donuts. In indicators: A) Students analyze the principles of conventional and modern biotechnology and B) Distinguish between simple biotechnology and modern biotechnology. Questions are made in the form of stories so that they require students to

have reading literacy skills. If students lack reading literacy, these students will have problems understanding the questions. The results of interviews with students showed that students did not understand the content of the question text

made in a story. This indicates that students did not get complete information related to the information told in the question text. So that the score on the question is low.

masih banyak lagi produk-produk yang memanfaatkan mikroorganisme dalam proses fermentasi (2)  
 Aplikasi bioteknologi dalam bidang pertanian dapat membantu dalam percepatan produksi benih, perbaikan sifat-sifat tanaman, hingga menghasilkan jenis tanaman baru. Semua itu bisa dihasilkan dengan cara rekayasa genetika. Rekayasa genetika adalah suatu usaha memanipulasi suatu gen organisme untuk tujuan tertentu, dengan cara menghilangkan atau menambahkan suatu gen sehingga menghasilkan organisme dengan sifat-sifat yang diinginkan (3) sebagai contoh:

- a. Jagung manis. Jagung manis yang kita konsumsi saat ini merupakan jagung hasil rekayasa genetika. Pada jagung manis gula yang terkandung direkayasa untuk tidak diubah menjadi pati sehingga tetap manis dan berair (4).
- b. Pepaya California, pepaya ini juga merupakan hasil rekayasa genetika oleh seorang profesor dari IPB, yang memiliki kelebihan rasa lebih manis dan cepat berbuah (5).

3. Konteks kalimat di atas menggambarkan penerapan prinsip bioteknologi, pada pernyataan kalimat manakah yang menunjukkan prinsip bioteknologi modern

- a. 1 dan 2
- b. 1 dan 3
- c. 2 dan 4
- d. 3 dan 4

**Figure 4.** Questions in the form of stories for the indicator “Distinguishing Simple Biotechnology and Modern Biotechnology.”

Figure 4 shows a snippet of C4 questions. Problems are constructed by presenting a discourse that requires students to have reading literacy skills. If students' reading literacy skills are low, students will find it difficult to analyze information. This is in line with the statement [Hasanah dan Warjanah \(2019\)](#). This states that students' reading literacy skills will affect the ability to interpret reading and students' HOTS contents.

In indicator (F) Conducting a simple mini-research applying fermentation in making donuts, the score is also low. This is because previously, the students had never done mini-research on making donuts. The questions for this indicator have the dimension of procedural knowledge. For

the dimensions of procedural questions, if students have never done the procedure, students will face obstacles in answering questions with the dimensions of procedural knowledge (Figure 5).

The score at the C6 cognitive level is still below the KKM score. Cognitive level C6 is the highest cognitive level, so that it requires students to think complexly (figure 6). The prerequisite for this ability is to analyze and evaluate. This is in line with the research results ([Sara, et al., 2020](#)) C6 is the highest level of cognitive processing. Student achievement at this level can be lower than C4 or C5.

Aisyah dan teman-teman sekelompoknya akan praktikum membuat donat , tetapi aisyah belum mengetahui cara membuat donat. Apa yang harus aisyah lakukan ?

- Mencukupkan diri untuk untuk bertanya ibu dan kakak
- Menyalin catatan teman dari kelas lain yang telah praktikum membuat donat
- Mencari informasi di berbagai sumber tentang cara membuat donat
- Asiyah menunggu teman-teman yang lain mencari informasi cara membuat donat

**Figure 5.** Questions on the Dimensions of Procedural Knowledge on the Indicator "Doing a Simple Mini Research Applying Fermentation Principles in Making Donuts"

Seperti disebutkan sebelumnya, Aisyah ingin menggunakan tiga jenis tepung untuk menghasilkan voume adonan mengembang dan kualitas donat. Apa jawaban yang tepat untuk pertanyaan penelitian aisyah ?

- Adanya pengaruh kehidupan ragi terhadap volume adonan mengembang dan kualitas donat
- Adanya pengaruh kualitas donata terhadap jenis tepung dan volume adonan mengembang
- Adanya pengaruh volume adonan mengembang terhadap kualitas donat dan jenis tepung
- Adanya pengaruh jenis tepung terhadap volume adonan mengembang dan kualitas donat

**Figure 6.** Snippets of Procedural Knowledge Dimensions at the C6 Cognitive Process Level Proses

HOTS is an important ability possessed by students, so teachers need to make efforts to improve students. Teachers can prepare learning strategies that can increase students' HOTS. The involvement of students in learning is the key to obtaining HOTS by students (Puspaningtyas, 2018).

Teachers can use problem-based learning models (Nurhayati dan Lia, 2017), inquiry, discovery learning, project learning, and other activity-based models to improve higher-order thinking skills. The learning model mentioned above can provide HOTS if the teacher designs it by considering the activities that provide HOTS, such as analyzing, evaluating, and creating.

## CONCLUSION

Based on the data and discussion, it can be concluded that the HOTS questions for Grade IX students at one of the MTs in the Sukabumi Regency still need to be improved. Many factors can affect students' HOTS abilities, for example, mastery of knowledge, reading literacy skills, and other abilities. Teachers can choose various activity-based learning models to increase students' HOTS.

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