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# Learning Outcomes of Students Taught Using HOTS-Based Discussion in Fungal Biology

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**ABSTRACT**

This study aimed to describe student learning outcomes after the implementation of Higher Order Thinking Skills (HOTS)-based discussion in fungal biology learning. The research employed a quantitative approach using a One-Shot Case Study design. The subjects of the study were 13 fifth-semester students enrolled in the Botany and Life of Lower Plants course in a Biology Education program. The learning intervention was conducted through classroom discussions using analytical, reasoning-based questions related to fungal concepts. Student learning outcomes were measured through a post-test consisting of case-based questions and analyzed using descriptive quantitative statistics, including mean, standard deviation, and percentage distribution across achievement categories. The results showed that the mean post-test score was 77.7, with scores ranging from 75 to 80. All students (100%) achieved at least the "Good" category, with 76.92% classified as "Good" and 23.08% as "Very Good." The relatively low standard deviation (1.75) indicated an even distribution of learning outcomes among students. These findings indicate that student learning outcomes in fungal biology following HOTS-based discussion were predominantly in the good to very good categories.

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## 1. Introduction

The Lower Plant Botany course is one of the fundamental pillars in the Biology education curriculum that has a high level of complexity. The scope of the material includes an introduction to morphological structures, reproductive mechanisms, and organism classification systems. In this study, the focus is limited to the material on fungi (mushrooms). The study of fungi has great urgency because of their vital role in maintaining ecosystem balance as the main decomposers and providers of nutrients for plants through mycorrhizae (Campbell & Reece, 2010). In addition to ecological aspects, mastery of fungi material is crucial for students because of its broad potential in the fields of biotechnology, food, and medicine, but on the other hand it also has urgency in the health sector related to its pathogenicity in humans


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and plants (Rahmawati, SI, 2017; Gitosuwondo, Subowo, et al, 2010; Aprillia , D., Riniarti, M., & Bintoro, A., 2019; Putra, IP, & Mycology, PD, 2020). A thorough understanding of fungal diversity and biology is essential for students to apply this knowledge in the context of bioeconomics and environmental conservation. The complex nature of fungal material, its rich scientific terminology, microscopic structural differences, and complex life cycles, often trap students in rote learning. Yet, mastering the material at the university level requires more than just low-level cognitive skills such as remembering *or* understanding. Students are required to analyze and synthesize complex biological concepts, such as evolutionary adaptation and the ecological roles of organisms. The primary challenge in this learning process is how to transform the learning process from passive-receptive to active-analytical.

One strategic solution that can be implemented is through the implementation of a face-to-face discussion method specifically designed by providing reasoning-based questions (*Higher Order Thinking Skills* - HOTS). The use of questions that trigger reasoning in discussions is crucial because it forces students to connect various concepts, evaluate phenomena, and create solutions (Thahir, R., Magfirah, N., & Anisa, A., 2021; Ramdani et al., 2021; Riski, D., Wahyuni, R., & Novianti, N., 2023). Discussion is a process of seeing two or more individuals who interact verbally and face to face regarding predetermined goals or objectives through the exchange of information (Sugiharto, RAA, & Anistyasari, Y., 2022). A quality discussion is not just a question-and-answer forum to confirm facts, but a dialectical space where students are trained to think critically through scientific argumentation. The advantage of this reasoning-based discussion method lies in its ability to build knowledge construction independently. When students are faced with questions that do not have direct answers in the textbook, they are encouraged to engage in information literacy and collaborate intensively with their peers. This process not only improves mastery of the material but also hones 21st-century skills, including critical thinking and communication skills (Seriada, IW, 2021; Maryati, E., 2022; Sugiharto, RAA, & Anistyasari, Y. (2022)). Face-to-face interactions provide lecturers with the opportunity to directly observe students' thought processes and address misconceptions. Reason-based learning through discussion has been shown to be significantly more effective in improving long-term memory retention than conventional lecture methods, which tend to be one-way. Through discussion, students actively process information from various perspectives, resulting in a more comprehensive and lasting understanding (Amrain, I., Panigoro, .M, Ardiansyah, A., Bumulo, F., Bahsoan, A., 2024; Ratih, A., 2015).

Given this urgency, this study aims to evaluate the effectiveness of the face-to-face discussion method through a *One-Shot Case Study approach* . The main focus of this study is to describe student learning outcomes after being given an intervention in the form of analytical problem-based discussions on the topic of Fungi. The results of this study are expected to provide an objective picture of the extent to which the reasoning-based discussion method can optimize students' cognitive achievement on the topic of fungi.

## 2. Method

### Research Design

This study employed a quantitative approach using a One-Shot Case Study design. This design is part of Pre-Experimental Design, in which a group is given a treatment and then measured or observed after the treatment to examine the effect of the independent variable (Sugiyono, 2017).

The research design can be illustrated as follows:

$$X - O$$

Where:

X = Treatment in the form of face-to-face discussion using reasoning-based (HOTS) questions on fungal material

O = Observation (post-test) to measure student learning outcomes

### Research Subjects

The research subjects were 13 fifth-semester students of the Biology Education Study Program, Faculty of Social and Political Sciences, University of Muhammadiyah Surabaya, academic year 2025/2026, who were enrolled in the course Botany and Life of Lower Plants.

### Research Variables

The variables in this study are operationally defined as follows:

Independent Variable: Face-to-Face Discussion Method Based on Reasoning. This variable was operationalized through small group interactions in class using worksheets containing analytical cases on fungal biology. This variable represents the treatment given to students.

Dependent Variable: Student learning outcomes operationalized as students' scores obtained from their answers to the questions on the student worksheets.

### Research Procedure

The research procedure was conducted in three main stages:

1. Arranging categorized question items *Higher Order Thinking Skills* (HOTS) on Fungi material.
2. At the intervention stage, Students are given brief introductory material about Fungi.
3. Students are divided into small discussion groups to solve case-based problems.
4. Discussions are conducted face-to-face with the lecturer as a facilitator who provides guidance when needed.
5. Discussions focused on problem solving.

### Data Collection Technique

Learning outcome data was obtained through assessment of written responses to case-based questions contained in the student worksheets. Assessment was conducted using rubric that included aspects of analytical depth and the use of scientific arguments. Scores from each aspect were summed to obtain a final score on a scale of 0–100. The numerical scores were then converted into qualitative categories (Very Good, Good, Fair, Poor).

Table 1. Score Ranges and Final Score Categories

| Score Range | Category |
|---|---|
| **≥ 80** | Very good |
| **72–79** | Good |
| **66–71** | Enough |
| **< 65** | Low |

**Data Analysis**

Data analysis was conducted quantitatively and descriptively to calculate the mean and standard deviation of learning outcome scores, as well as the percentage of student achievement in each category (very good, good, sufficient, and low). This analysis aims to describe the effectiveness of the treatment on the collective student learning outcome profile.

## 3. Results and Discussion

### Results

Student learning outcome data was obtained through a *post-test instrument* administered after the entire series of face-to-face discussion methods based on reasoning (*Higher Order Thinking Skills*) were completed. The research subjects were 13 students.

The analysis of the research results is presented in the form of descriptive statistics and frequency distribution of value categories.

**Description of Learning Outcome Statistics**

Based on data processing of 13 respondents, a general overview of student learning outcomes was obtained as follows:

Table 2. Descriptive Statistics of Post-test Scores of Student Learning Outcomes

| Descriptive Statistics of Post-test Scores of Student Learning Outcomes | |
|---|---|
| N (Number of Subjects) | 13 |
| Mean | 77.7 |
| Median | 78 |
| Standard deviation | 1.75 |
| Minimum | 75 |
| Maximum | 80 |

Table 2 shows the average student learning outcome after the discussion was 77.7. The lowest score obtained by students was 75.00, which means all students had exceeded the threshold of sufficient scores (<72). The relatively low standard deviation (1.75) indicates that the distribution of student scores was fairly even or that there was no extreme gap in understanding between students in the group.

**Frequency Distribution Based on Score Category**

To more specifically assess the quality of learning outcomes, scores were grouped based on established criteria. The results of this grouping are presented in Table 3.

Table 3. Distribution of Learning Outcome Scores by Category

| Mark | Category | Amount | % of Total |
|---|---|---|---|
| ≥ 80 | Very good | 3 | 23.08 |
| 72-79 | Good | 10 | 76.92 |
| 66-71 | Enough | 0 | 0 |
| <65 | Currently | 0 | 0 |

The data in Table 3 shows the dominance of achievement in the "Good" category, namely 10 students (76.92%). Meanwhile, there were 3 students (23.08%) who managed to achieve the "Very Good" category with a maximum score of 80. Overall, the success rate of learning using this face-to-face discussion method reached 100% in terms of achieving the minimum score of the "Good" category.

Visually, the distribution of learning outcome scores based on categories is made in a pie chart in Figure 1.

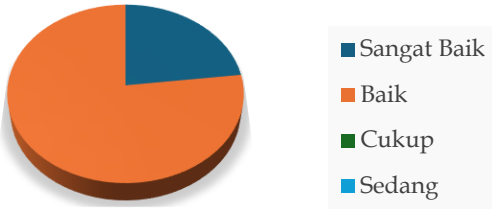


**Figure 1. Distribution of Students' Learning Outcome Scores by Category**

**Analysis of Achievements Based on HOTS Level**

Based on the test instrument provided, the questions are classified into three HOTS cognitive levels according to Bloom's Taxonomy: Level C4 (Analysis), C5 (Evaluation), and C6 (Creation/Synthesis). The following are examples of questions and student answers.

a. Level C4 (Analysis)

Question:

Fungi have cell walls made of chitin, not cellulose. How does this affect how fungi interact with their environment?

Student Answer:

Chitin offers greater durability and strength than cellulose. The unique presence of chitin allows fungi to interact with all types of organisms, even in extreme environmental conditions. Chitin protects fungal cells from mechanical damage as the mycelium penetrates soil, rocks, and other plant debris, ensuring proper decomposition. Chitin provides protection as the mycelium penetrates the root and stem cortex of its host plant, as it participates in parasitic interactions.

Achievements:

The average score is 82%, meaning that students are very proficient in describing the relationship between structure and function.

b. Level C5 (Evaluation)
Question:
Location Y (Wet/Freshwater Area): Dead aquatic plants and insects are decomposed by a network of non-septate hyphae, often appearing like white cotton. What are the organisms at Location Y classified as? Why can the aseptate (non-septate) hyphal structure of these organisms be interpreted as a primitive or less efficient adaptation strategy compared to septate hyphae?
Student answer:
The structure of a septet hyphae is considered more primitive or less efficient because it lacks septa. The absence of septa means that if damaged, the entire cell will be destroyed, leading to the release of cytoplasm. The presence of septa limits injury or damage, allowing other parts of the cell to continue living.
Achievements:
Average score: 75%. Students are beginning to be able to provide critical assessments of biological phenomena.

c. Level C6 (Creation/Synthesis)
Question:
Imagine suddenly losing all Myxomycetes and Phycomycetes from an ecosystem. Predict the most significant direct and indirect impacts on nutrient cycling in nature.
Student Answer:
Myxomycetes and Phycomycetes play a role in humus formation and soil structure maintenance because of their decomposer activity. If this process is not carried out, the soil becomes compacted and its nutrient content is low. This disrupts the cycles of phosphorus, potassium, and calcium. Consequently, plants that are essential for human health will have difficulty obtaining nutrients due to infertile soil, thus reducing plant productivity. This will ultimately impact on the food chain and ecosystem quality.
Achievements:
Average score 71%. By developing an ecological impact scheme, students demonstrate higher-order thinking skills (C6). Students are able to synthesize various ecosystem parameters to develop a new understanding of the important role of Myxomycetes and Phycomycetes in maintaining nutrient cycle stability. Students are sufficiently capable of synthesizing various ecosystem concepts to strengthen their analysis of the important role of Myxomycetes and Phycomycetes in life.

**Discussion**

The results showed that all students (100%) successfully exceeded the "Sufficient" category. Most students were in the "Good" category (76.92%), with a class average of 77.69.

This success is influenced by the implementation of the face-to-face discussion method. Discussion is a situation where educators and students or students and other students converse and share ideas and opinions (Ermi, N., 2015). In discussions, students are not only passive listeners but are required to re-explain the concept of fungal material (such as the life cycle of Zygomycota or Ascomycota) to their peers.

The explanation process helps strengthen memory retention and deepen understanding. Face-to-face discussions also allow for more active nonverbal interaction and discussion than online learning or one-way lectures. Meanwhile, Samani (2012) states that discussion is the sharing of opinions. Between two or more people with the aim of reaching a common view on a problem that is shared. Thus, discussion is a learning method that inside it there is a conversation between individuals and other individuals who are formed into a forum or group that is faced with a problem so that they can exchange ideas to find the right solution to the problem through mutual agreement.

The One-shot Case Study design has limitations due to the absence of a comparison (pre-test), the high concentration of scores in the "Good" and "Very Good" categories provides a strong indication that the face-to-face discussion intervention has a positive impact on student learning outcomes.

Providing reasoning-based questions (analysis and evaluation) during this discussion session proved to be a key factor in its success. These questions required students not only to memorize the reproductive phases of fungi but also to analyze the relationship between these phases and environmental conditions. This aligns with the findings of Wartono et al. (2019), who emphasized that inquiry-based learning and group discussions focused on real-world problems can significantly improve students' critical thinking skills and cognitive learning outcomes.

Furthermore, face-to-face discussion methods involve non-verbal communication and immediate feedback. Lecturers can identify misconceptions during the discussion and provide direct intervention. This is consistent with Zhafirah et al. (2022) who stated that this discussion method is an interactive process where teachers need to guide students to develop their thinking skills through interaction. Interaction in small group discussions aims to optimize class mastery and engage students' attention while delivering the material.

Collaboration in discussions also increases learning motivation. Students feel a shared responsibility in solving the given reasoning problems. Furthermore, HOTS (Higher Order Thinking Skills)-based classroom discussions significantly improve critical thinking skills (Sipahutar et al. 2024). This explains why the lowest student score in this study remained at 75 (Good category), due to the socio-cognitive support among students throughout the learning process.

The effectiveness of this method is also enhanced using challenging questions, which encourages students to move from lower-order thinking skills to higher-order ones. Familiarizing themselves with *Higher Order Thinking Skills* (HOTS)-based questions in class discussions can improve student learning outcomes. HOTS questions train students to analyze, evaluate, and create, thereby developing their

higher-order thinking skills. Face-to-face discussions create a dynamic learning environment where ideas are tested and debated, a crucial process in higher education science education.

This research shows that biology students need to be trained to think critically, not simply memorize material (such as the reproductive stages of fungi). Through direct discussions, students learn to solve complex biological problems logically. These higher-order thinking (HOTS) skills are crucial for prospective teachers so they can properly guide high school students in conducting research or scientific inquiries. Sharp reasoning is a key asset for teachers in explaining difficult and abstract science lessons to their students.

On the other hand, there is a weakness in the One-Shot Case Study design because it does not compare it with another group (the control group). Therefore, the improvement in student learning outcomes cannot be guaranteed solely due to the discussion method. Other factors that influence the improvement in learning outcomes include the students' They are already in their advanced semesters, so their mindset and knowledge are more mature. Furthermore, students can more easily access any information via the internet. Students learn independently during the research process.

However, there are several key factors that contribute to the students' excellent learning outcomes (with an average score of 77.69). These factors include:

a) The small student population. Because there's only one lecturer for every 13 students, interactions are more intimate, and lecturers can provide direct, personalized feedback to each student.
b) Challenging questions. Students cannot rely solely on memorization but are forced to think actively and critically to solve difficult problems.

Face-to-face discussions. A supportive classroom atmosphere allows students to learn from each other and help their peers more effectively.

## 4. Conclusions

Based on the research results, it can be concluded that the application of the face-to-face discussion method based on reasoning (HOTS) resulted in high student learning outcomes. All students (100%) obtained scores in the minimum category of Good, with an average post-test score of 77.7, a minimum score of 75, and a maximum score of 80. The relatively even distribution of scores is indicated by a standard deviation of 1.75.

Providing reasoning-based questions improves students' critical thinking skills and cognitive learning outcomes.

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