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Development of Biology Learning Modules Based on Scientific Literacy To Improve *Higher Order Thinking Skills* of MA Students on Fungi Material

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Abstract

Higher Order Thinking Skills (HOTS) are crucial skills that need to be mastered and cultivated in the 21st-century education. Thus, there is a need for innovative open materials to aid in the development of high-level thinking abilities. This research aims to develop a module based on scientific literacy that is valid, practical, and effective for students. The instruments used include needs analysis through teacher interviews and student questionnaires, validation sheets for media and material experts, and practicality sheets. Additionally, a pre-test post-test sheet is used for effectiveness assessment. Based on the data analysis results, the teaching materials validation received a score of 98.3%, the material validation received a score of 88.3%, the teacher response questionnaire received a score of 92.5%, and the student response questionnaire received a score of 90.4%. The effectiveness assessment yielded an N-Gain score percentage of 71.4%, falling under the high category. Therefore, it can be concluded that the Scientific Literacy-based Module is considered feasible, practical, and effective in facilitating the development of higher order thinking skills.

Keywords: Module Development; Scientific Literacy; Higher Order Thinking Skills

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INTRODUCTION

21st-century education places great emphasis on the development of four essential abilities: creativity, critical thinking, collaboration, and communication (Kemendikbud, 2016). This modern approach to education combines knowledge, skills, and attitudes to equip students for the challenges of the globalized world. A key aspect of this approach is the cultivation of Higher Order Thinking Skills (HOTS), which are essential for preparing students to tackle complex issues (Kemendikbud, 2016).

The Qur'an also emphasizes the importance of seeking a means to draw closer to God and striving in His way for success (QS. Al-Maidah: 35). In this verse, the term "wasilah" denotes an intermediary or medium. Educational media play a vital role in transmitting messages and stimulating students' thoughts, emotions, and motivations, thereby facilitating the learning process (Asnawir et al, 2002).

Higher Order Thinking Skills encompass critical, logical, reflective, metacognitive, and creative thinking (King, Goodson, & Rohani, 2012). These skills come into play when individuals encounter unfamiliar, uncertain, and challenging problems. Examples of higher order thinking skills include analysis, evaluation, logical reasoning, critical thinking, problem-solving, and creative thinking (Brookhart, 2010). Engaging in these processes fosters students'

ability to think critically, logically, and reflectively (Sole & Anggraeni, 2020). Integrating Higher Order Thinking Skills into the learning process serves as an implementational strategy for the 2013 curriculum, as it enables students to thrive in the current global competition (Kemendikbud, 2016).

Based on the results of the Programme for International Student Assessment (PISA), which has been conducted every three years since 2000, Indonesian students consistently rank among the lowest performers, typically around the 65th position (Kemdukbud, 2016). Although there has been some improvement in Indonesia's PISA results in 2015, the increase remains insignificant, with the country still ranking 63rd out of 70 participating nations (OECD, 2016). The poor performance of Indonesian students in PISA can be attributed to their weak aptitude in solving non-routine or higher-level problems, which require Higher Order Thinking Skills (OECD, 2016). In accordance with the findings of the PISA research, the evaluation of interviews conducted with biology teachers at MAS Al-Washliyah 22 Tembung also revealed that the students' Higher Order Thinking Skills (HOTS) abilities were relatively low, particularly in the areas of analysis and evaluation. The indicators used in the learning process predominantly ranged from the C1 to C4 levels. Analysis of the student test results indicated that questions categorized as C1 accounted for 20%, C2 accounted for 20%, C3 accounted for 20%, C4 accounted for 15%, C5 accounted for 15%, and C6 accounted for 10% of the total questions. These percentages indicate a relatively small emphasis on higher order thinking skills.

Research conducted by Stein and Lane (2013) suggests that HOTS problems require complex thinking, lack clear algorithms for solution, are difficult to predict, and often demand alternative approaches to existing problems or examples. Similarly, Ramos's (2013) study demonstrates that the low level of HOTS among students arises from difficulties in performing analysis, evaluation, and creative processes due to the lack of relevant questions being posed.

Further research by Sobirin (2016) has shown that only 12.5% of students were able to successfully answer questions categorized as HOTS, while 87.5% excelled in the Lower Order Thinking Skills (LOST) category, which includes basic remembering, understanding, and application abilities. The deficiency in higher level thinking skills can be attributed to the learning methods employed, which focus primarily on memorization, writing, and exercises, and offer limited opportunities for students to tackle real-world problems in unconventional and concrete ways (Syamsurizal et al., 2021). As Ernawati (2017) points out, high-level thinking should encompass more than mere memorization, but should also involve integralistic thinking, analysis, and the ability to draw conclusions based on creative and productive ideas.

One recommended learning model that aligns with the HOTS approach and the implementation of the 2013 Curriculum is the Science Literacy learning model. According to Adisendjaja (2003), scientific literacy refers to the ability to utilize scientific knowledge to identify problems, draw evidence-based conclusions, and understand and make decisions regarding nature and the changes brought about by human activities. Additionally, the 2015 PISA assessment defines scientific literacy as an individual's skill in formulating questions, acquiring new knowledge, and providing scientific explanations for phenomena. Poernomo et al. (2021) suggest that Science Literacy learning can enhance students' HOTS abilities and self-efficacy, as this approach enables them to actively engage in higher level thinking while investigating the presented concepts and attempting to solve problems.In the realm of education, it is crucial to utilize media that engages students and prevents boredom during the learning process (Tafanao, 2018). Modules serve as a tool to aid and facilitate learning activities. According to Prastowo (2011), a module is a source of fundamental information that can be further developed and supplemented with communicative illustrations and photos. Majid (2008) asserts that modules can enhance student activity in developing their critical thinking skills and problem-solving abilities. Sulastri (2018) supports this idea, stating that the use of modules can enhance students' higher-order thinking skills (HOTS). Along similar lines, implementing modules based on the Scientific Literacy model has been shown to improve

students' abilities for high-level thinking (Wiharto, 2019). These scientifically literate modules explicitly address the challenges associated with teaching sub-materials.

One of the topics covered in Biology for grade X in the 2013 curriculum is Fungi. The study of Fungi delves into the characteristics of fungi on both macroscopic and microscopic levels. To effectively teach this material, an appropriate learning model and interactive learning media, such as those containing images, are necessary to facilitate students' comprehension of the Fungi subject matter (Ansori, et al. 2008).

Prior research conducted by Zeni Anggriani (2019) has demonstrated the ability of Science Literacy-based Modules to enhance students' HOTS in 10th-grade science classes. Additional studies by Nurul Fahmi, et al (2023), Rabiudin (2023), Atif Budiono, et al (2021), Sriharyanti Riska (2017), Fatiatun, et al (2019), Pratiwi, et al (2018), and Sarni Warningsih (2019) support the successful use of Science Literacy-based Modules in improving student learning outcomes. Yusuf Hilmi's research, reviewed by Adisendjaja (2003), has also demonstrated that these modules are valid, practical, and effective in enhancing students' HOTS. However, no previous research has specifically focused on the development of modules for the Fungi material. Thus, there is an opportunity for researchers to explore the development of a Science Literacy-based Module specifically tailored to improve HOTS in the context of Fungi material. Based on observations, the selection of Fungi material was driven by the perception of the biology teacher at MAS Al-Washliyah 22 Tembung, who identified Fungi as a particularly challenging topic for students. This perception arises from the abstract nature of the concepts involved, which makes teaching them quite difficult and increases the risk of misconceptions (Amida et al., 2020).Based on the observations conducted at the MAS Al-Washliyah 22 Tembung school, it has been found that biology teachers frequently utilize worksheets as a means of media, focused on incorporating higher order thinking skills (HOTS). However, there appears to be a deficiency in students' comprehension, despite the acknowledged significance of higher level thinking in fostering critical thinking abilities, creativity, and self-assurance (Maridi, et al., 2017).

This research is motivated by the aforementioned background, aiming to develop a learning module based on the subject of Fungi Material Science Literacy, with the intention of enhancing HOTS. To date, no studies have been discovered that specifically address the development of modules centered around Fungi material. Thus, it is hoped that this research will provide valuable contributions by improving both the students' learning outcomes and the validity, practicality, and effectiveness of the learning process. By introducing novel variations to the students' learning process, it is expected that their active engagement and high-level thinking will be stimulated, thereby promoting a more productive and enriching learning experience.

METHOD

Research Design and Procedures

The type of research used in this research is *Research and Development* (R&D). This research was used to produce a product in the form of a Science Literacy-based Module. The approach model used is the 4D model proposed by Thiagarajan (1974), namely Define, Design, Develop, and Disseminate. During the definition stage , problems with the learning process are identified. The defining stage state is used to guide the design stage media compilation. In the development stage, replies from biology teachers and class The *Dissemination* stage consists of implementing the product with students as well as testing the effectiveness of achieving the module objectives.

Validity analysis. practicality analysis, and effectiveness analysis are some of the data analysis methodologies used. The validity test was carried out using a module validation sheet created by academics. The following Likert scale was used to assess the module: very valid,

valid, quite valid, not very valid and very invalid. After being assessed by the validators, the data is calculated and then the results of the collected data will be presented in Table 1.

The data analysis technique in the validity test uses *a Likert scale* with a range of 1 to 5 and each question has a choice of 1 to 5 with the following formula 1:

$$P = \frac{Jumlah\ skor\ jawaban\ masing-masing\ skor}{jumlah\ skor\ ideal\ item} X\ 100\% \quad \text{..... (1)}$$

0-20 was considered invalid, 21-40 was deemed not valid, 41-60 was categorized as quite valid, 61-80 was considered valid, and 81-100 was regarded as very valid (Dermawati et al., 2019). To calculate the percentage of participants who provided responses in each category of the questionnaire sheet, a correction was made using the following formula:

$$N\,P = \frac{R}{SM} X\ 100\% \text{..... (2)}$$

Information:
N.P. : Mark Percentage Which expected
R : Score obtained
SM : Score maximum

After percentage obtained, done grouping in accordance criteria for achieving practicality. Student responses are said to meet the very practical criteria if they are at an achievement level of 81-100%. Practical if 61-81%. Less practical 41-60%. Impractical 2-40%, and < 21% is very impractical (Husnita & Saputri, 2023).

Effectiveness analysis is based on student achievement when completing learning outcomes tests. Measuring the effectiveness of newly developed products using pretest and posttest tests on students during field tests. To find out whether or not the developed LKPD is successful in increasing learning outcomes, a comparison of the normalized *N - gain values* or N-gain equation is carried out:

$$N - gain\ (\%) = \frac{(Skor\ Postest - Skor\ Pretest)}{(Skor\ maksimal - Skor\ Preset)} x\ 100 \text{..... (3)}$$

Results score *gain* normalized shared to in three category , n a m e l y N-gain <0.3 is less effective, 0.3≤ N-gain ≤0.7 is quite effective, and N-gain > 0.7 Effective (Yunipiyanto et al., 2020).

Table 1. Likert Scale Validation Test (Mukti & Nurcahyo, 2017)

Achievement (%)	Category
90-100	Very Valid
80-89	Valid
65-79	Fairly Valid
55-64	Less Valid
0-54	Very Invalid

A practical analysis was carried out on the data collected through the responses of biology teachers and students. The collected data was taken from the trial process with a Likert scale of 1-5 and then categorized into practicality categories in Table 2.

Table 2. Likert Scale Practicality Test

Achievement (%)	Category
90-100	Very Practical
80-89	Practical
65-79	Quite Practical
55-64	Less Practical
0-54	Very Impractical

Effectiveness analysis is carried out to see whether the module development objectives have been achieved. For effectiveness, this module uses a posttest and pretest which include Higher Order Thinking Skills indicators , namely analyzing, evaluating and creating Higher Order Thinking Skills which consists of 10 essay questions. Effectiveness test data will be analyzed and calculated using the N-gain formula. The score results are interpreted in Table 3.

Table 3. N-gain Formula Value Range

Score Range	Criteria
N - gain > 0.7	Effective
0.3 ≤ *N - gain* ≤ 0.7	Effective enough
N - gain 0.3	Less effective

A questionnaire with 10 questions can be used to assess *Higher Order Thinking Skills* and also indicators of analyzing, evaluating and creating. To find out how to analyze, evaluate and create students related *Higher Order Thinking Skills* , the raw score can be divided by the highest score, multiplied by a constant (100%). The score results are interpreted in table 4.

Table 4. Range of Higher Order Thinking Skills Intervals (Eviyanti et al., 2022)

Intervals (%)	Category
66.6 < *P* ≤ 100	Tall
33.3 < *P* ≤ 66.6	Currently
0 < *P* ≤ 33.3	Low

RESULTS AND DISCUSSION

Module design is carried out through several stages, the initial design begins with the define stage. The define stage begins with carrying out various analyzes aimed at obtaining information regarding module development needs (Maulidatul et al., 2019). The researcher first conducted an interview with one of the biology teachers at a private Madrasah Aliyah school regarding matters relating to media, materials and also students' views on the environment studied in class. After collecting information based on interviews, researchers developed a biology learning module based on scientific literacy on fungi material. The module design can be seen in Figure 1.

Figure 1. Science Literacy Module Design

The design step or module design stage is filled with initial product design in making a scientific literacy-based module on fungal material for class X SMA/MA. At this stage, researchers prepared and collected various books as references regarding fungal material. Preparation of module designs and assessment instruments is also carried out so that the modules are in accordance with the content framework to be designed. In the module, scientific

literacy is also applied through assignments and various activities so that students are able to understand and apply it in everyday life.

Validation Analysis

The scientific literacy-based fungus module product design has been validated by 3 expert validation people. The content or content of the module will be assessed by material expert validation, the design and appearance of the module will be assessed by media expert validation. Material experts validate the quality aspects of the module objectives and the quality of learning in the module. After development was carried out with several suggestions from validation during revision, a conclusion was obtained on the validity of the module. The results of material expert validation can be seen in Table 5.

Table 5. Material Expert Validation

Aspect	Idealized Percentage	Category
Content Eligibility Feasibility of presentation	88.3 %	Valid

Media experts validate aspects in terms of module coverage, cover aspects, typography aspects, and module design aspects. The results of media expert validation calculations can be seen from Table 6.

Table 6. Media Expert Validation

Aspect	Idealized Percentage	Category
Module Size Closing Font Typography Design Module	98.3 %	Very Valid

Based on Table 6, it is known that the percentage score from material experts is 88.3% or it can be concluded that the scientific literacy-based function module is said to be valid. Meanwhile, the percentage score from media experts was 98.3%, which shows that the scientific literacy-based function module is said to be Very Valid. Suggestions and responses from validators aim to determine the feasibility of the scientific literacy-based module that has been developed before conducting field trials (Ramdoniati, et al, 2018). Validity assessment can be seen from several aspects such as content, presentation, language and visual appearance (Mutmainah et al., 2022).

Teacher and Student Responses

Data on the practicality of using the module was obtained through a response questionnaire from biology teachers and class X MAS students after the module was used in the learning process. Data on the practicality of teacher responses is shown in table 7.

Table 7. Teacher Responses

Respondent	Score	Category
Class X Biology Teacher at Private Madrasah Aliyah	92.5 %	Very Practical

Based on the biology teacher response questionnaire, it is known that the module is stated to be very practical for use in learning with a score percentage of 92.5%. The module is categorized as practical because it can be used in the learning process and can be used as an independent learning medium by students. This is in line with (Azis et al., 2023), activities that can be carried out using modules can be carried out independently, such as practicums, solving problems, and creating projects.

This is in line with Gunawan's (2019) opinion that the aim of preparing modules is to increase students' passion for learning and help students learn independently. Students are encouraged to be able to think at a higher level (Atika et al., 2023). Apart from that, modules are essentially used by students for learning, therefore student responses will be really needed in module development. The number of students who became respondents was 36 people who would then fill out a response questionnaire to the module being developed. The results of Oktariana et al.'s research. (2023) stated that the module received a better response compared to learning using conventional textbooks. The scientific literacy approach invites students to understand the scientific skills a person has in defining questions, acquiring new knowledge, explaining phenomena scientifically (Poernomo et al. 2021; Hariyadi et al., 2023; Rasmi et al., 2023). After obtaining the response questionnaire scores from 36 students, the practicality percentage was then calculated and the following results were obtained in table 8.

Table 8. Student Responses

Total Respondents	Percentage (%)	Category
36 Students	90.4 %	Very Practical

Based on the results of the practicality questionnaire, it is known that the scientific literacy-based function module has been categorized as practical because it received a score of 90.4% and in the research it was found that the module can be used independently by students because there are instructions for use that are in accordance with the purpose of the module itself. This agrees with Al Fatihah et al, (2022), Scientific Literacy is one solution that is considered to be able to improve or hone understanding of concepts. Apart from that, the research also found that the module facilitates learning because it has directed goals in accordance with KD. This also agrees with Hidayah et al., (2023) that scientific literacy assisted by teaching materials can improve students' abilities.

Effectiveness of Modules in Improving *Higher Order Thinking Skills*

Testing the effectiveness of the scientific literacy-based function module was carried out by giving questions and questionnaires before and after using the module to 36 students. This effectiveness test was carried out to test the use of the module to improve *Higher Order Thinking Skills* . In this effectiveness test, 3 indicators are used, namely analyzing (C4), evaluating (C5) and creating (C6) according to King et al., (2012).

For indicator coverage, analyzing, evaluating and creating consists of 10 essay questions. The before and after effectiveness test data by students will be analyzed using N-Gain calculations, which can be seen in table 9 and effectiveness is proven through pretest-posttest analysis to measure students' high-level thinking abilities (Figure 1).

Table 9. Effectiveness Test Data for N-Gain Results

Pre-test	Post-test	N-Gain(%)	Criteria
39.6	82.8	71.4 %	Effective

Based on Table 9 and Figure 2, it can be seen that the results of the N-Gain carried out at Private Madrasah Aliyah received a total score of 71.4% in the effective category. The results of the pre-test and post-test scores that have been tested also show an increase in scores.

Next, coverage of higher order thinking behavior indicators (Higher Order Thinking Skills) was carried out with a questionnaire consisting of 10 questions. Before and after effectiveness test data by students will be analyzed by calculating the raw score divided by the maximum score multiplied by a constant. The results of this data were analyzed to obtain the changes listed in Table 10.

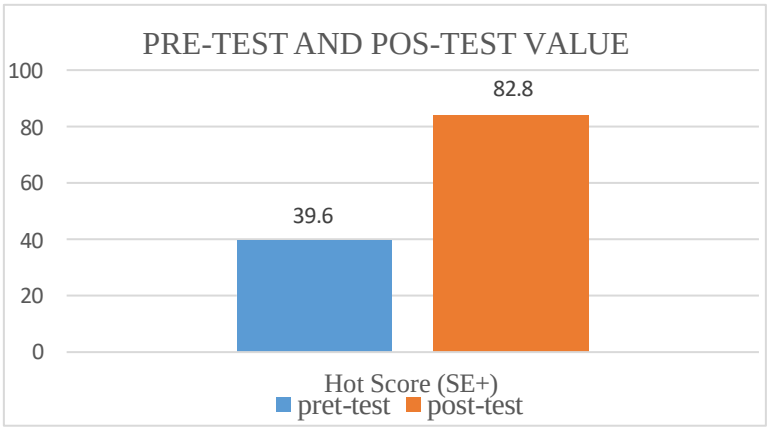

Figure 2. Pretest-Posttest diagram

In the questionnaire before using the module, the average questionnaire score was 39.6 in the medium category and in the questionnaire after using the module the average questionnaire score was 82.8 in the high category. This illustrates that the module can be said to be effective in improving students' *Higher Order Thinking Skills* . Then these results are in line with Sarni Warningsih (2019) that the scientific literacy module will provide a unique opportunity for students to experience something related to scientific phenomena. To achieve students who have insight into scientific phenomena, scientific literacy is needed (Sriharyanti Riska., 2017).

Table 10. Increasing Module Effectiveness

Higher Order Thinking Skills Evaluation	Average	Category
Previous Questionnaire	39.6	Currently
After Questionnaire	82.8	Tall

By using a Science Literacy-based module, students are required to understand defining questions, obtain new knowledge, explain phenomena, so as to create a learning atmosphere that involves student activity when learning takes place. This is in line with the opinion of Wiharto (2019) that the form of student activity in learning can be seen from the involvement of students in the learning process, such as being involved in understanding, defining questions, acquiring new knowledge, explaining phenomena. This is very in line with the application of scientific literacy indicators.

The scientific literacy-based module is suitable for the students' learning process because it has been proven to be effective by obtaining module effectiveness results in the N-Gain category, namely high and in the effective category. The application of scientific literacy is proven to be able to increase HOTS, this is proven by the results of the effectiveness of tests given to students before learning using the module begins, where students' scores related to HOTS are on average very low and the test carried out after learning using the module begins, it turns out that other research proves that the scientific literacy-based module can grow students' HOTS, through validation tests, the practicality and effectiveness of this scientific literacy-based module can increase students' HOTS, through training questions that can stimulate students to analyze, evaluate and create in various ways. discoveries and discussions carried out.

CONCLUSION

Based on the research that has been conducted, the Scientific Literacy-based Module is an effort to create valid, practical and effective teaching materials designed to improve students' high-level thinking skills on reproductive system material. The development of a Science Literacy-based Module product is considered feasible, practical and effective for improving students' high-level thinking abilities. However, this research still has limitations

and aspects of testing for a larger population scale and varying ability measurement variables. Therefore, the researcher's suggestion for future researchers is to expand the population reach in implementing the Module in schools, varying the biology material taught and measuring other aspects of skills.

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