Implementation of Multiple Representation-Based Fungi E-module on Students' Cognitive Learning Outcomes and Writing Communication Skills

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Article Info	Abstract
	Since the COVID-19 pandemic that hit Indonesia in 2020, the teaching and learning process has been carried out through the online method. Some of the obstacles to implementing online learning are that teachers cannot deliver the material directly, there is limited time for online learning, and the lack of teaching materials that can be used to accompany students' independent learning from home. E-modules are complete teaching materials with electronic formats that are prepared with the aim of assisting students' independent learning. Meanwhile, multiple representations are an approach to conveying material concepts in various forms of representation to help students understand the material presented. This study aims to examine the effectiveness of the application of multiple representation-based fungi e-module in improving students' cognitive learning outcomes and writing communication skills. The research was conducted at SMA Negeri 1 Tayu in the odd semester of the 2021-2022 academic year. The method in this study is a quasi-experimental method with a nonequivalent control group pretest-posttest design. The research sample was obtained by purposive sampling technique, namely class XI MIPA 3 as the experimental class and class XI MIPA 4 as the control class. The research data were obtained from pretest, posttest, investigation reports, and student self-reflection questionnaires. The results showed that there was an increase in cognitive learning outcomes with the acquisition of an average N-gain score of 0.56 (56.08%) in the medium category in the experimental class and 0.34 (34.50%) in the control class with the medium category. In the students' written communication skills which were analyzed by the Mann-Whitney test, the results of the Asymp score were obtained. Sig. (2-tailed) <0.05, i.e. 0.026, which means that there is a significant difference between the written communication skills of the experimental class students and the control class. Student self-reflection questionnaire used as supporting data showed that there were differences in the percentage results in several statements, especially on data presentation indicators. Based on the results of this study, it can be concluded that the application of the multiple representation-based fungi e-module is effective for improving cognitive learning outcomes and there are differences in students' writing communication skills.

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INTRODUCTION

Since March 2, 2020, Indonesia has been hit by cases of the COVID-19 pandemic. The case of this pandemic has had many impacts on life, one of which is the impact on education. (Susilo, Aditya; et al. , 2020) stated that as of March 31 2020 there were 1.528 confirmed cases of COVID-19 in Indonesia wit 136 deaths. One of the government rules in the education sector is learning from home. According to the Circular of the Minister of Education and Culture of the Republic of Indonesia No. 4 of 2020 concerning the Implementation of Education Policies in the Emergency Period for the Spread of Corona Virus Disease (COVID-19) states that the process of implementing education policies is carried out by learning from home.

Since the learning from home policy was established, the face-to-face teaching and learning process in schools was abolished. One way to implement this learning from home policy is to conduct online learning. The online learning is a teaching and learning process carried out on the internet network. Online learning is also often referred to as distance learning (PJJ) whose implementation always uses technology.

The process of implementing learning from home has several weaknesses. One of them is that teachers cannot deliver learning materials directly or face to face with students. Obstacles in the process of delivering material indirectly and the limited hours of online learning resulted in a decrease in the ability to understand the material by students. As a result, students tend not to understand the concept of the material that has been delivered. Therefore, students are required to actively carry out independent learning from home with or without teacher guidance.

The demand to carry out learning independently from home requires learning resources that can be used online or offline and are flexible. Based on the survey results at SMA Negeri 1 Tayu, the teaching materials used by students during distance learning are still textbooks from schools and summary files distributed by teachers. The use of digital technology will allow the learning process in different places. A module is one type of teaching material that is a complete package and is specifically designed to help students understand a material independently. Modules are teaching materials that are equipped with self-study instructions for students. Modules intended for students are designed to help students reconstruct concepts through reading and to train students' thinking skills independently through structured tasks integrated in the module.

A module can come in two forms, that is printed and electronic modules (E-Module). E-module are more practical than print modules because they can be used by anyone, anytime, and anywhere as long as there is an electronic device used as the display media. Of course, during this pandemic, the use of technology is an obligation to be able to continue activities from home, including learning activities from home that must be carried out by students.

In addition to having practical elements, the e-module also has the advantage of loading animation, audio, and navigation where these elements are not found in the print module. Elements of text, images, and audio contained in the e-module can help students to relate facts, concepts, procedures, and principles to the material presented. Multiple representations are a way to represent the same concept again with various forms of representation (verbal, pictures, graphics, and mathematics). According to (Doyan, M. Taufik & R. Anjani, 2018), multiple representations are one approach to conveying material by combining text, images, symbols, and graphics to be able to improve students' understanding of the material. Lestari (2016) states that multiple representations are an approach to presenting information in various forms of different representations to make it easier for students to understand learning materials. This multiple representation approach is in line with the elements contained in an E-Module.

According to (Ainsworth, 2006) states that pedagogically multiple representations have 3 functions, that is: complementary information, constrain interpretation, and construct deeper understanding. Furthermore, Treagust & Tsui (2013) also mentions that multiple representations in biology have 3 elements, that: mode of representainaion, level of representation, and domain of knowledge.

Biology is a science that has a broad object of study. Not only about the mechanisms of organ systems that occur in the body, but also includes biodiversity and phenomena that occur in nature. The object of biological study includes things that can be seen directly (macroscopic) and also indirectly

(microscopic). Many studies report on biological materials that are considered difficult by students, one of which is fungi material. According to Nurhalisa (2017), the fungi material is considered difficult by students because the diversity of fungi includes many species including species that are not able to be presented directly by the teacher in the learning process. This causes students to only be able to imagine the types of fungus without knowing them for sure.

(Musriadi & Rubiah, 2014) also stated that in addition to the fungi material considered difficult by students, in the implementation of learning in the classroom there is also a lack of biology teaching materials that can help students understand the concept of fungi material. Therefore, there is a need for teaching media that are packaged in independent teaching materials for students and can present various types of fungi diversity, both macroscopically and microscopically, virtually. In the 21st century, every individual is required to have both soft skills and hard skills. One of the skills that must be mastered in the 21st century is the skill to learn and innovate (Learning and Innovation Skills). These skills have four aspects of skills, known as 4-C, that is Critical Thinking, Communication, Collaboration, and Creativity.

Based on the demands of competence and analysis of the problem, the fungi material must be presented in such a way that it can help students to understand the concept of the material independently with or without teacher guidance while implementing the learning from home. The use of the multiple representation method to present material in various representations can be applied in an e-module that contains many audiovisual elements. Therefore, based on this thought, it is necessary to research " Implementation of Multiple Representation-Based Fungi E-Module on Students' Cognitive Learning Outcomes and Writing Communication Skills".

RESEARCH METHOD

The research was conducted at SMA N 1 Tayu in the odd semester of the 2020-2021 academic year. The research method used was a quasi-experimental method with a pretest-posttest nonequivalent control group. The population of this study was all students of class XI department mathematics and natural sciences, totaling 7 classes. While the sample of this study was class XI MIPA 3 as the experimental class, and class XI MIPA 4 as the control class. The sampling technique used in this study is a non-random technique, which is purposive sampling. The data in this study are the students' cognitive learning outcomes and writing communication skills obtained from pretest-posttest assessments, reports on investigation results, and student self-reflection questionnaires.

RESULTS AND DISCUSSION

This research aims to determine the effectiveness of the implementation of multiple representation-based fungi e-module on students' cognitive learning outcomes and writing communication skills. The research was carried out during the biology learning hours of SMA Negeri 1 Tayu for classes X MIPA 3 and X MIPA 4. Due to the research being carried out during the Covid-19 pandemic, the research was carried out online by using the online application. The research was conducted in three meetings with details: implementation of the pretest at the first meeting through Whatsapp Group and Google Forms, delivery of material and discussion at each meeting through the Whatsapp Group, assignment of investigation and posttest through Google Meet, Google Classroom, and Google Forms. The data obtained in this study include basic data i.e. cognitive learning outcomes and results of student investigation reports, and supporting data i.e. student self-reflection questionnaires. The pretest and posttest data in this study were analyzed by the N-Gain Score test to determine the effectiveness of implementing e-modules in increasing students' cognitive learning outcomes. Meanwhile, the investigation report data were analyzed using the Mann-Whitney test to determine differences in the writing communication skills of the two sample classes. Data on students' writing communication skills in this study were supported by student self-reflection questionnaire data which were analyzed by looking for percentages and interpreted based on a Likert scale.

Students' Cognitive Learning Outcomes

Data on students' cognitive learning outcomes were obtained from the results of the pretest and posttest on the fungi material using multiple choice questions, totaling 30 questions. Statistical descriptive data on student cognitive learning outcomes in each sample class are presented in Table 1. Data on cognitive learning outcomes were then analyzed by using the N-gain test in Table 2.

Table 1. Statistical descriptive analysis of pretest-posttest experimental class and control class

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Pretest Eksperimen	36	10	73	40.28	15.265
Posttest Eksperimen	36	37	100	72.80	20.667
Pretest Kontrol	36	13	80	39.72	15.191
Posttest Kontrol	36	23	97	60.74	21.331
Valid N (listwise)	36				

Table 2. Analysis of the average score of N-gain for each sample class.

The Value Data	Experimental Class	Control Class
Pretest	40.28	39.72
Posttest	72.80	60.74
N-Gain	0.56	0.34
N-Gain (%)	56.08 %	34.50 %

Based on the descriptive statistical analysis of the pretest and post-test results contained in Table 1. it can be seen that the experimental class has an average pretest value of 40.28 while the control class has an average value of 39.72. Based on these results, it can be seen that the two sample classes departed under the same conditions. Meanwhile, based on the posttest results, the experimental class had an average of 72.80 while the control class had an average score of 60.28. The KKM standard used in SMA Negeri 1 Tayu is 70. Based on the post-test results, shows that there are differences in cognitive learning outcomes between the experimental class and the control class.

To determine the effectiveness of the application of the multiple representation-based fungi e-module in this study, the N-Gain test was carried out. Based on the results of the N-Gain score analysis in Table 2. The experimental class has an average N-gain score of 0.56 in the "medium" category, and the control class has an average N-gain score of 0.34 also in the "medium" category. The results of the N-Gain test analysis prove that the application of the multiple representation-based fungi e-module is quite effective in improving students' cognitive learning outcomes in the experimental class.

The implementation of the multiple representation-based fungi e-module in the experimental class showed better results than the control class that did not use the e-module. This difference in results is because the multiple representation-based fungi e-module helps students in the experimental class to deepen their understanding of the material. E-module presents the material in various forms of representational modes such as text, images, tables, audio, and video to help students better understand and deepen the material.

In addition to the fungi kingdom material which is presented in several modes and levels of representation, the e-module also includes practice questions that are equipped with keys and discussion. Practice questions in the e-module are presented at the end of each learning activity. This is used as a reference for student decisions when studying independently with an e-module (continue to the next chapter or repeat the previous chapter). To facilitate student self-study, practice questions in the e-module are integrated with Google Forms which can automatically see the results and discussion by students. This makes students in the experimental class have more learning experiences and understand the material than students in the control class so the increase in cognitive learning outcomes from the experimental class is

greater than in the control class.

The results of this study are in line with research conducted by Raharti (2011) that student learning outcomes become better with the use of module media in learning. The increase in cognitive learning outcomes in this study is also in line with research conducted by (Doyan, M. Taufik & R. Anjani, 2018) that there is a positive effect of learning with a multiple representation approach which can be seen from the increase in students' cognitive learning outcomes. This is because the multiple representation approach can present material in various formats that can improve student understanding. A similar study conducted by Leksana (2017) states that a multiple representation approach can be used to build a deeper understanding. Through multiple representations, an abstract concept can be made more concrete in several forms of representation.

The use of multiple representation-based e-module in learning proves information processing events in experimental class students. According to information processing theory, learning is the processing of information in the human brain which consists of three stages, namely: observation/sensing, information storage, and inference/coding to be subsequently issued. In this study, the multiple representation-based fungi material e-module acts as information that is captured by the students' senses to be stored in memory and used at a later date.

Based on the data and the results of this study, it was shown that by using multiple representation-based e-module students' cognitive learning outcomes in the experimental class improved better than in the control class. This is evident in the implementation of learning, experimental class students are more enthusiastic and play an active role in responding to stimulation and conducting online discussions compared to students in the control class who tend to be more passive. This is because by using multiple representation-based e-module students become more enthusiastic and do not feel bored in learning. In contrast students in the control class tends to feel bored with conventional learning activities (without using an e-module) so only certain students follow and pay close attention to online learning. This is what causes differences in cognitive learning outcomes between the two sample classes.

In addition, in this study e-module are used as companion teaching media whose role is to help further clarify existing teaching materials, for example, school textbooks which tend to present material only with written representations. With the existence of multiple representation-based e-module, students can better understand the material according to their respective learning styles. Learning style is the easiest way for everyone to absorb, organize and process the information received (Bire, Arylien Ludji; Uda Geradus & Josua Bire, 2014). According to Deporter & Hernacki (2007), learning styles are divided into three types, that is visual learning styles, auditory learning styles, and kinesthetic learning styles. Each student has their learning style depending on their comfort in obtaining and absorbing information.

Learning style is one of the factors that influence student learning outcomes. According to research conducted by (Ningrat, Sayu P.; M. Teguh & M. Sumantri, 2018), states that the average student has more than one learning style. The use of learning styles that are limited in one form/type causes inequality in absorbing information. On the other hand, students who can combine the three types of learning styles will have maximum learning outcomes. Fungi material e-module which was compiled based on the multiple representation approach in this study helped maximize students' learning styles in absorbing information so that students could master and achieve the learning objectives set.

Writing Communication Skills

Data on students' communication skills in this study were obtained from data on students' writing skills in compiling reports on investigation results, and student self-reflection questionnaires as supporting data. Data on students' communication skills were collected using non-test instruments, i.e. the assessment instrument for the investigation report and the questionnaire instrument. Statistical descriptions of the results of the investigation report in each sample class are presented in Table 3.

Tabel 3. The results of the statistical descriptive analysis of the investigative results of the experimental class and control class.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Laporan Investigasi Kelas Eksperimen	36	70	95	84.58	6.801
Laporan Investigasi Kelas Kontrol	36	50	95	76.67	13.939
Valid N (listwise)	36				

Then to find out the differences in students' communication skills, the Mann-Whitney test was carried out on the report data of the students' investigation results. The Mann-Whitney test in this study was carried out as an alternative test for the Independent sample t-test. The Mann-Whitney test was used in this study because the data obtained from the student investigation reports were not normally distributed so in this study the independent sample t-test could not be performed. The results of the Mann-Whitney test are presented in Table 4.

Tabel 4. Table of the results of the Mann-Whitney alternative test on the value data of student investigation reports.

Test Statistics[a]	
	Laporan Hasil Investigasi
Mann-Whitney U	453.500
Wilcoxon W	1119.500
Z	-2.227
Asymp. Sig. (2-tailed)	.026
a. Grouping Variable: Kelas	

Meanwhile, the data from the students' self-reflection questionnaires about the knowledge of writing skills were recapitulated to see the percentage of each indicator. The percentage recap of the results of the students' self-reflection questionnaire analysis can be seen in Table 5.

Tabel 5. Percentage of results of student self-reflection questionnaire analysis

| No	Student Response Statement	Experiment Class	Category	Control Class	Category
A.	**Knowledge of Report Systematics**				
1.	I can compile investigative reports.	69.44%	Good	68.33%	Good
2	I can name parts of the investigative report.	66.67%	Good	67.78%	Good
3	I compile a report on the results of the investigation coherently and completely following the reporting systematic rules.	71.67%	Good	72.22%	Good
4	Sometimes I ask my friends when I feel confused and have difficulty compiling a report on the results of the investigation.	44.44%	Enough	45.56%	Enough
5	I searched and copied the theoretical basis from investigative reports on the internet for practical purposes.	38.89%	Enough	49.44%	Enough
6	I find it difficult to conclude an investigative report.	40.56%	Enough	41.11%	Enough
B.	**Knowledge of Grammar and Language**				
7	I understand the Indonesian spelling and grammar used in the investigation report.	68.89%	Good	69.44%	Good
8	I compiled a report on the results of the investigation	72.22%	Good	73.89%	Good

	using language according to the rules.				
9	I don't know the rules for writing a bibliography.	28.33%	Enough	35.56%	Enough
C.	**Data Presentation Knowledge**				
10	I conduct and search investigationdata independently.	76.67%	Very good	76.11%	Very good
11	I find it difficult to find data investigating the role of mushrooms from an accurate source.	48.33%	Enough	53.33%	Good
12	I present observational data in the form of sentences, pictures, tables, etc.	84.44%	Very good	78.89%	Very good
13	I always try to explain the investigative data that has been obtained in my own words.	72.78%	Good	72.78%	Good
14	I have a hard time explaining data using tables, graphs, concept maps, etc.	42.78%	Enough	44.44%	Enough
15	I copied some or all of the results of the investigation data belonging to a friend.	19.44%	Not good	24.44%	Not good

From the report data on the results of student investigations which can be seen in Table 4. it is known that students in the experimental class have a minimum report score of 70 and a maximum score of 95 with an average value of 84.58. Meanwhile, students in the control classhad a minimum report score of 50 and a maximum score of 95 with an average score of 76.67. Based on the results of the descriptive statistical analysis, it can be seen that there are differences in the results of the investigative report scores between the experimental class and the control class.

Furthermore, based on the results of statistical analysis using the Mann-Whitney test on the value of the investigative report from the two sample classes, the asymp value was obtained. Sig. (2-tailed) of 0.026 or less than 0.05, which means that there are differences in writing communication skills between students with the application of the multiple representation-based fungi e-module and those who do not.

The results of the analysis of the results of student investigation reports showed that the two sample classes had the same maximum score and the average value of the two sample classes passed the KKM. The difference in written communication skills between the two sample classes is evidenced by the results of the students' self-reflection questionnaire analysis. From Table 5. it is known that the indicators of knowledge of systematics, writing, and language in both the experimental class and the control class tend to have the same percentage of knowledge and ability of written communication skills. However, if you look further at the data presentation knowledge indicator, several statements have different percentages, such as in the questionnaire statements number 11, 12, 14, and 15. The following is an image of a summary diagram of the percentage of students' self-reflection questionnaires on data presentation indicators.

Figure 1. Summary of the percentage of student self-reflection questionnaires on data presentation indicators.
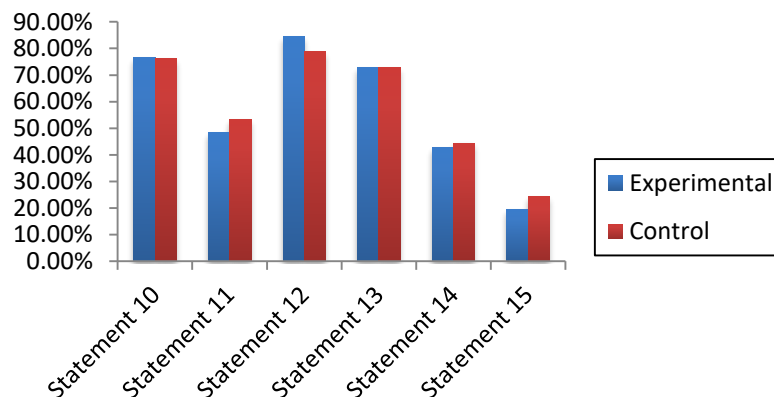
In negative statement number 11 which states that students find it difficult to find data on the investigation of the role of fungi from an accurate source, the experimental class gets a percentage of 48.33% while the control class is 53.33%. This means that the level of difficulty in finding data on the role of fungi from accurate sources by the experimental class is lower than the control class. This is because

during the learning process the experimental class is facilitated with multiple representation-based e-module that present examples of research articles on the role of fungi in the learning activity sheet (LAB) segment.

The LAB in the e-module directs students to conduct investigations and compile reports on the results of investigations about the diversity of fungi and their role in life. The explanation is presented in a text representation mode, accompanied by examples of research articles on the role of fungi such as wood rot, lichen symbionts, and tempeh mushrooms. The sample article was then used as material for student analysis in the experimental class so that the level of difficulty of experimental students in finding investigative data from accurate sources was lower than that of the control class students.

Furthermore, in the positive number statement number 12 which states that students present observational data in the form of sentences; pictures; tables; and others., the experimental class got a percentage of 84.44% while the control class had a percentage of 78.89%. Thus the skill of presenting observational data in the form of multiple representations by the experimental class is higher than the control class. This happens because the experimental class learning process uses e-module learning media which displays kingdom fungi material in various multiple representation forms. The learning process in the experimental class makes students more aware of forms of multiple representations so that students are better able to present investigative data in various forms of representation.

In addition, in negative statement number 14 which states that students have difficulty explaining the data using tables; charts; concept maps; etc., the experimental class has a percentage of 42.78% and the control class has a percentage of 44.44%. In other words, students in the experimental class had a lower level of difficulty in explaining the data using various forms of multiple representations than students in the control class. The results of the response to statement number 14 also support the results of student responses to questionnaire statement number 12 above. This reinforces that the use of multiple representation-based e-module helps students in the experimental class to more easily explain investigative data in various multiple representational forms.

However, in statement number 13 which states that students always try to explain the investigative data that have been obtained in their own words, both the experimental class and the control class got the same percentage, which is 72.78%. This shows that in the process of preparing the report on the results of the investigation, both the experimental class and the control class students have made the same effort to compose a discussion of the investigative data in the form of their respective sentence representations.

For questionnaire statement number 15, the two sample classes show a fairly large percentage difference. However, this negative statement number 15 is only an explanation that students in the experimental class are more independent in finding investigative data than the control class. In negative statement number 15 which states that students copy some or all of the results of investigation data belonging to friends, the experimental class gets a percentage of 19.44% while the control class is only 24.44%. This shows that 80.56% of students in the experimental class did not copy the results of their friends' investigation data, while in the control class only 75.56% of students did not copy the results of their friends' investigations. The response to statement number 15 also supports the results of the response to statement number 10. In positive statement number 10 which states that students conduct and explore investigative data independently, the experimental class also has a higher percentage than the control class, although the difference is not so much.

From the explanation of the students' self-reflection questionnaire analysis, it can be seen that the multiple representation-based fungi e-module helps students in the experimental class to be able to compile reports investigations better than in the control class. Therefore, the results of statistical analysis of the reported value on the results of student investigations between the experimental class and the control class showed a significant difference.

The results of this study are in line with research conducted by (Patriot, 2019) which states that the use of a multiple representation approach in learning helps students to more easily understand concepts. The multiple representation-based fungi e-module which presents the material in various forms of representation provides an opportunity for students to be able to understand the concept of material based on their respective specific abilities.

According to Oktaviani's research (2010), through reports students can write down ideas that are in their heads to be poured into writing form. According to (Ita & Andini Mega Saputri, 2021), presenting the results of the practicum into a report requires the ability to process data and information effectively so that it is easily understood by readers of the report. In terms of compiling reports on the results of investigations, students who use e-modules can present data, write discussions, and draw conclusions based on the results of investigations that are related to the concepts that have been studied through previous e-modules. Based on the results of the analysis of student investigation reports, the majority of students have been able to fulfill the components of the investigative report completely and correctly.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the implementation of the multiple representation-based fungi e-module is effective in improving cognitive learning outcomes and students' writing communication skills at SMA Negeri 1 Tayu.

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