

Development of audiovisual media on “Mold” material based on guided inquiry to improve students’ critical thinking skills

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Abstract

The needs analysis shows that students must improve their critical thinking skills. The number of students who could differentiate various types of mold conidia based on their structure was also smaller. The purpose of this research and development was to test the effectiveness of audiovisual media on the topic “Mold” based on Guided Inquiry on “Microscope Using Techniques, Description of Colony Morphological Characteristics, and Mold Microscopy” to improve students’ critical thinking skills. This type of research is a quasi-experimental study with the Non-randomized Pretest Posttest Control Group design and follows the stages of the development model from Lee and Owens. Data collection uses validation sheets, response questionnaires, pretest, and posttest questions. Data analysis used the N-Gain score and the Mann Whitney test. The results of the study showed that there was a significant difference between the experimental class which was taught using audiovisual media on the topic “Mold” based on Guided Inquiry, compared to the control class which was taught using conventional Power Point (PPT) media without audiovisual media, so it can be concluded that the media audiovisual on the topic “Mold” is effective in improving students’ critical thinking skills.

Abstrak

Analisis kebutuhan menunjukkan mahasiswa masih perlu meningkatkan keterampilan berpikir kritis. Jumlah mahasiswa yang mampu membedakan macam-macam konidia kapang berdasarkan strukturnya juga lebih sedikit. Tujuan penelitian dan pengembangan ini adalah untuk menguji keefektifan media audiovisual pada topik “Kapang” berbasis *Guided Inquiry* tentang “Teknik Penggunaan Mikroskop, Deskripsi Ciri-ciri Morfologi Koloni, dan Mikroskopis Kapang” untuk meningkatkan keterampilan berpikir kritis mahasiswa. Jenis penelitian ini adalah penelitian kuasi eksperimental dengan desain *Non-randomized Pretest Posttest Control Group* dan mengikuti tahapan model pengembangan dari Lee dan Owens. Pengumpulan data menggunakan lembar validasi, angket respon, soal *pretest* dan *posttest*. Analisis data menggunakan *N-Gain score* dan uji *Mann Whitney*. Hasil penelitian menunjukkan bahwa ada perbedaan signifikan antara kelas eksperimen yang dibelajarkan dengan menggunakan media audiovisual pada topik “Kapang” berbasis *Guided Inquiry*, dibandingkan dengan kelas kontrol yang dibelajarkan dengan menggunakan media *Power Point (Ppt)* secara konvensional tanpa media audiovisual, sehingga dapat disimpulkan bahwa media audiovisual pada topik “Kapang” efektif meningkatkan keterampilan berpikir kritis mahasiswa.

A. Introduction

The qualifications of students graduating from the Bachelor's program are regulated in the Indonesian National Qualifications Framework level six (Miller & Sternberg, 2021). The publication of the Indonesian National Qualifications Framework is Presidential Regulation Number 8 of 2012 and Law Number 12 of 2012 concerning higher education which requests and supports all universities to adapt to the provisions stated in the Indonesian National Qualifications Framework (Junaidi, 2020). Based on Presidential Regulation Number 8 of 2012, the description of the qualifications for the Indonesian National Qualifications Framework level six includes: 1) being able to apply their field of expertise and utilizing Science, Technology and Arts in their field in solving problems and being able to adapt to the situations faced; and 2) can master the theoretical concepts of certain fields of knowledge in general and specifically in depth, and be able to formulate procedural problem solving (Gurning, 2015).

Based on these definitions, the sixth level of the Indonesian National Qualifications Framework for students taking the Bachelor's program is required to fulfill the qualifications of the Indonesian National Qualifications Framework which is expected to be able to educate and forge students, so that they are expected to be able to apply their fields of expertise and utilize Science, Technology and the Arts to solve problems faced in everyday life, be able to master theoretical concepts in depth, be able to make decisions critically, wisely, and be able to take responsibility for the work they do.

Level six qualifications for students at the *Universitas Negeri Malang*, majoring in Biology, Bachelor of Biology study program can be achieved by taking 146 Semester Credit Units. One of the courses taken by students majoring in Biology is Microbiology as a mandatory subject (Katalog dan Kurikulum Jurusan Biologi FMIPA UM, 2020). The competency of this course requires students to understand the properties and role of fungi in everyday life. Learning outcomes for the Microbiology course include: 1) students are able to understand the concepts in Microbiology; 2) students are able to understand the properties and role of microbes in everyday life; 3) students are able to understand the application of Microbiology concepts in everyday life; and 4) students are able to master basic laboratory techniques and procedures for studying microbes.

The Indonesian National Qualifications Framework level six also requires students and lecturers to have 21st century life skills that they

should already have (Sole & Anggraeni, 2018). Critical thinking skills are skill that students need to have to meet the demands of 21st century life competencies (Fadel, 2015). This aims to ensure that students are able to keep up with the pace of development of science, information and communication technology, and are able to compete globally (Janah et al., 2019). Based on the Partnership for 21st Century Skills, there are four skills that students must have, namely: 1) critical thinking and problem solving skills; 2) creative and innovative thinking skills; 3) communication skills; and 4) collaboration skills (Fadel, 2015). Critical thinking skills are one of the 21st century life skills that need to be trained through the learning process (Redhana, 2019). Facts found in the field in previous research conducted by Rahayu et al. (2021) in her research on Elementary School Teacher Education students at the Sumedang Teacher Training and Education College in 2021 showed that it turns out that there are still many students who don't have critical thinking skills. This happens due to a lack of critical thinking practice during the learning process. Based on this description, critical thinking skills are one of the thinking skills that Biology students need to have, so these skills must be trained and developed for students through the lecture process as an effort to improve students' cognitive learning outcomes. This finding was also reported by Herlina et al. (2020), Purbarani et al. (2018), Kartikasari et al. (2021), Melindawati et al. (2021), and Susilowati et al. (2018).

Microbiology is a mandatory subject taken by students majoring in Biology, therefore there needs to be learning activities that train students' critical thinking skills. Students in everyday life often face problems related to Microbiology concepts. One example is the phenomenon of mold contamination of bread. Some students face problems regarding the appropriateness of consuming bread that has been covered in mold. They had to decide whether to eat the bread that had mold on it, or whether to just throw it all away. Students who are able to think critically will answer that it is best to throw away all the bread, because at the beginning of its growth, the white mold hyphae are the same color as the bread, so there is no visible mold growth. If the bread is still eaten, because there are no visible mold colonies, it could be dangerous to health, because there are species of mold that produce mycotoxins that can be eaten by them.

Another example of this phenomenon is that plants infected by pathogenic molds show symptoms including: yellow leaves and only a small

amount of fruit is produced. Students who are able to think critically will explain that plants attacked by pathogenic molds will experience chlorosis on their leaves with yellowish symptoms. This is caused by damage to the palisade tissue which plays a role in the photosynthesis process. The results of photosynthesis cannot be maximized, so only a small amount of fruit is produced.

Critical thinking skills consist of the ability to consider various information coming from various sources, being able to identify problems, analyze, evaluate problems, clarify, synthesize, and draw conclusions by deciding what is true and not true (Simanjuntak & Sudibjo, 2019). There are five indicators of critical thinking skills, namely: 1) applying; 2) evaluate; 3) use data to develop critical insights; 4) analyze; and 5) synthesize (Greenstein, 2012). Therefore, critical thinking skills can be improved with the help of the Guided Inquiry learning model.

The Guided Inquiry learning model can be used as a learning strategy for lecturers in arranging learning and practicum activities, especially on the topic "Mold", so that it can train students' critical thinking skills. Critical thinking skills can be trained optimally through the Guided Inquiry learning model, because students are given the opportunity to make observations and describe the morphological and microscopic characteristics of mold colonies, so that students not only know theoretical concepts, but students can train their critical thinking skills through practicum carried out.

This Guided Inquiry learning model involves students actively during the learning process through scientific investigations, thereby further improving students' conceptual understanding and making learning more meaningful. Trisnaa & Rahmi (2016) stated that the main targets of Guided Inquiry learning are: 1) during the learning process, students are maximally involved; 2) achieving directed, logical and systematic learning goals; 3) can develop a confident attitude in students about what they find during the inquiry process. The essence that can be concluded from Guided Inquiry learning is that the knowledge gained by students is not just about remembering facts and theories, but rather refers to learning activities that are self-discovery with the help of direct guidance from the lecturer. The syntax of the Guided Inquiry learning model used was adapted from Pedaste et al. (2015) includes stages: 1) orientation; 2) conceptualization; 3) investigation; 4) conclusion; and 5) discussion, so that the Guided Inquiry learning model is suitable for improving students' critical thinking skills.

The current learning media that is considered interesting for students is using audiovisual media, the use of audiovisuals involves the senses the most compared to other teaching aids, with audiovisuals students can see and hear (Ali & Poerwanto, 2017), so that teaching and learning activities become more effective, efficient, and learning objectives can be achieved optimally (Zahwa & Syafi'i, 2022). As the name suggests, audiovisual media is a combination of audio and visuals (Fitria, 2014). Each series of learning processes in it is linked, then enhanced with audio, video, and animation to enhance the learning experience (Nugraha & Nestiyarum, 2021).

This media will be more complete and optimal to support lecture activities and present teaching materials to students, apart from that, this media can, within certain limits, replace the role and duties of lecturers. In this case, the lecturer doesn't always play the role of presenter of material, but because the presentation of material can be replaced by media, the role of the lecturer can shift to become a learning facilitator, namely making it easier for students to learn. Audiovisual media that is developed must pay attention to several characteristics according to Kustandi & Darmawan (2020), namely: 1) the media is able to carry a number of message contents that will be conveyed to the listener; 2) the media contains values and morals; 3) media is arranged in accordance with developments in information technology in the era of globalization; 4) the media uses real learning; 5) the media is able to attract student interest and attention; 6) media is able to make students think critically; and 7) affordable for students' learning abilities. Following are some of the advantages of using audio visual media according to Nomleni & Manu (2018), namely: 1) presenting learning objects realistically, so it is very good for adding to the learning experience; 2) its audiovisual nature, so it has its own charm; 3) can motivate or act as a stimulus for learning; 4) can reduce learning boredom; and 5) can increase students' memory retention about the objects being studied. By observing photos of mold cultures, students are expected to be able to explain the morphological characteristics of mold colonies with the help of sound, so that it is clearer. Likewise, through observing photos of mold preparations, students are expected to be able to explain the parts of the mold body. This observation activity is assisted by sound as part of audiovisual facilities. Audiovisual media material on the topic "Mold" was prepared based on the results of a needs analysis, especially about things that students still need to know.

Based on a needs analysis questionnaire conducted by researchers on student respondents on January 9th 2022, it shows that students need to improve their critical thinking skills, this is proven by 43.8% of students not being able to differentiate between various types of mold conidia based on their structure. Based on the results of this student needs analysis questionnaire, only 25% of students were able to answer correctly. Apart from that, there are still some students who have not been able to solve problems correctly when answering questions about examples of problems that actually occur in everyday life, even though 100% of student respondents stated that students had received an explanation about the impact of consuming moldy food to health. One example is a question about a phenomenon in everyday life, namely the occurrence of mold contamination on bread. The question asked in the question is whether moldy bread should still be eaten on the part where mold doesn't grow, or should it just be thrown away altogether. Students who are able to think critically will answer that it is best to throw away all the bread, because at the beginning of its growth, the mold hyphae are white so it is not visible that there has been mold growth. If the bread is still eaten, it can be dangerous to health, because there are species of mold that produce mycotoxins. As many as 75% of students answered correctly, but 25% did not answer correctly, indicating that a small number of students were not able to think critically.

This research aims to prove the effectiveness of using audiovisual media on the topic "Mold" based on Guided Inquiry on "Techniques for Using a Microscope, Description of Colony Morphological Characteristics, and Microscopic Mold" to improve students' critical thinking skills.

B. Material and Method

The research design used was quasi-experimental with a non-randomized Pretest Posttest Control Group design. The population of this study were fourth semester students, class of 2021, majoring in Biology, FMIPA, *Universitas Negeri Malang* who were taking the Microbiology course. The research sample used two classes which were divided into two treatment groups, namely, the experimental class and the control class which had been tested for equality. The experimental class was taught using audiovisual media on the topic "Mold" based on Guided Inquiry, while the control class was taught using conventional PPT media, without using audiovisual media on the topic "Mold" in the learning process. Critical thinking skills are measured using pretest and posttest questions. The

effectiveness of audiovisual media on the topic "Mold" was analyzed using the N-Gain score to see the increase in students' critical thinking skills and continued with the Mann Whitney test to determine the differences in students' critical thinking skills between the experimental class and the control class. Criteria for the effectiveness of audiovisual media on the topic "Mold" based on the calculation of the N-Gain score value can be seen in Table 1.

Table 1 Evaluation Criteria for the Level of Effectiveness of Audiovisual Media

No.	N-Gain (%)	Category
1.	≥ 76	Effective
2.	56 - 75	Effective enough
3.	40 - 55	Less effective
4.	< 40	Ineffective

(Source: Hake, 1999)

Audiovisual media on the topic "Mold" was developed using the Lee and Owens model which consists of stages: 1) needs analysis and start-to-finish analysis; 2) design; 3) development; 4) implementation; and 5) evaluation (Lee & Owens, 2004). The implementation was carried out on students at the *Universitas Negeri Malang* which consisted of two classes, namely the control class and the experimental class. The control class used PPT teaching media according to that used by the lecturer, while the experimental class used the "Mold" audiovisual media based on Guided Inquiry to improve critical thinking skills.

C. Results and Discussion

This research resulted in laboratory experimental research and development research. The results of laboratory experimental research are in the form of Microbiology material regarding: 1) Microscopic Observation Techniques for Mold Preparations; 2) Observation and Description of Morphological Characteristics of Mold Colonies; and 3) Observation and description of the microscopic characteristics of mold, which are included in the learning media. A brief description of the contents of audiovisual media on the topic "Mold" is presented in Table 2, and excerpts of the cover page and table of contents of audiovisual media on the topic "Mold" are shown in the Figure 1 and Figure 2.

The description of the contents of the audiovisual media on the topic "Mold" is further shown in Figure 1 and Figure 2. Figure 1 shows a screenshot of the cover page of the audiovisual media on the topic "Mold" which contains: 1) audiovisual media title; 2) microscopic

photographs of mold; 3) author's name and editor's name; 4) Universitas Negeri Malang logo; and 5) identity of Universitas Negeri Malang, faculty, study program, and year of publication. Figure 2 shows an excerpt from the table of contents of audiovisual

media on the topic "Mold" which contains details of the titles and sub-headings in audiovisual media on the topic "Mold" and includes page numbers, making it easier for users when using audiovisual media applications on the topic "Mold".

Table 2 Description of Audiovisual Media Content on the Topic "Mold"

Audiovisual Media Contents	Information
Initial Part	Cover, foreword, table of contents, menu, user guide, basic theory, and basic techniques and procedures.
Core Section	<p>1st Learning Activities: "Techniques for Microscopic Observation of Mold Preparations"</p> <p>A. Students watch a practical video showing "Use of a Microscope and Microscopic Observation of Molds".</p> <p>B. Students are expected to be able to name the parts of a micro-scope and their functions, and be able to use the microscope properly and correctly.</p> <p>C. Students are expected to be able to understand the working techniques of using a micro-scope when observing mold pre-parations microscopically.</p> <hr/> <p>2nd Learning Activities: "Observation and Description of Morphological Characteristics of Mold Colonies"</p> <p>A. Students are expected to be able to describe the morphological characteristics of mold colonies based on: 1) color of the top surface of the colony; and 2) color at the base of the colony.</p> <p>B. Students are expected to be able to describe the morphological characteristics of mold colonies based on the nature of the colony.</p> <hr/> <p>3rd Learning Activities: "Observation and Description of Microscopic Characteristics of Mold"</p> <p>A. Students are expected to be able to observe mold preparations microscopically using appropriate and sequential steps.</p> <p>B. Students are expected to be able to describe the parts of the mold body based on the results of microscopic observations and write them on the observation sheet.</p>
Closing Part	Structured Assignments, Glossary, Summative Test, Reference List, and Author Profile.

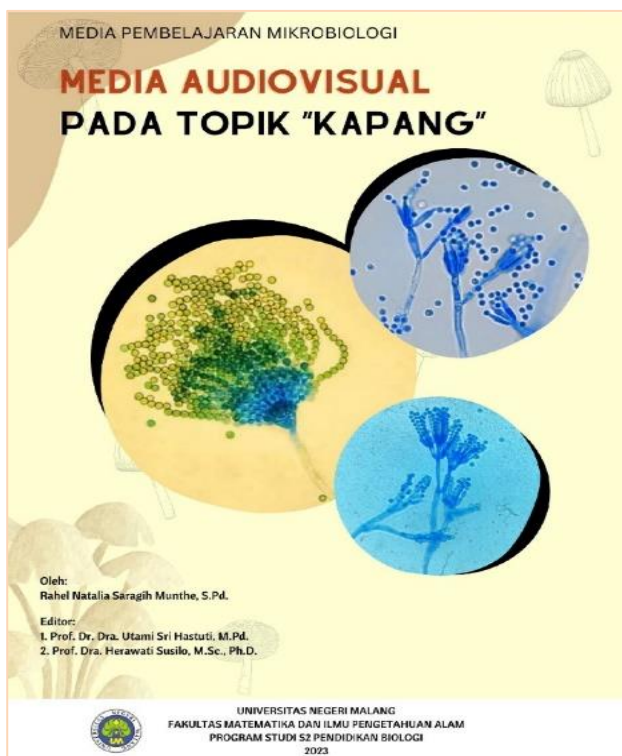


Figure 1
 Cover page from "Mold" audiovisual media (in Indonesian)

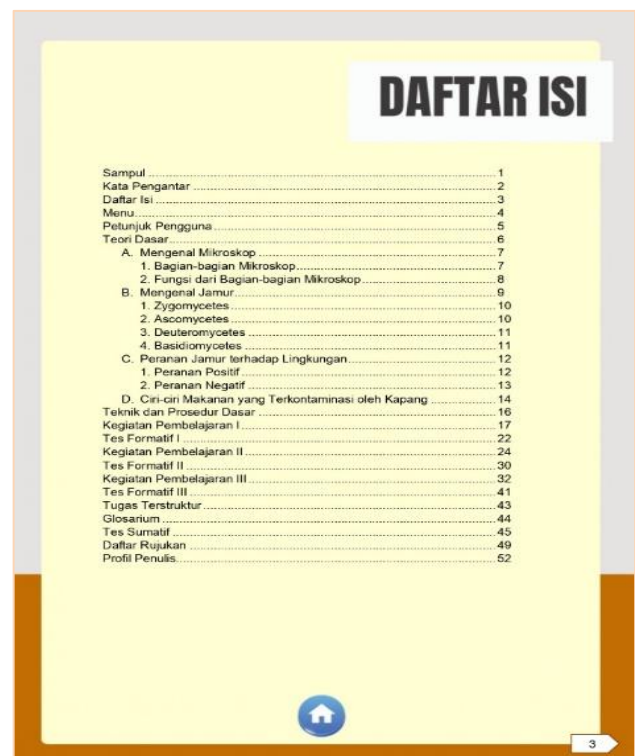


Figure 2
 Table of contents from "Mold" audiovisual media (in Indonesian)

Table 3 N-Gain Score Value

Variable	Class	Average Value		N-Gain	Category
		Pre-test	Post-test		
Critical Thinking Skills	Experimental	66	93	79%	Effective
	Control	70	82	41%	Less effective

Table 4 Normality Test Results for Critical Thinking Skills

Variable	Class	Shapiro-Wilk		
		Statistic	f	Sig.
Critical Thinking Skills	Experimental	0,632	30	0,000
	Control	0,824	31	0,000

Table 5 Mann Whitney Test Results for Critical Thinking Skills

Variable	Class	N	Mean Rank	Sig. (2-tailed)
Critical Thinking Skills	Experimental	30	35,88	0,022
	Control	31	26,27	

The effectiveness of audiovisual media on the topic "Mold" based on Guided Inquiry on "Techniques for Using Microscopes, Description of Colony Morphological Characteristics, and Microscopic Mold" was obtained based on the N-Gain score from the pretest and posttest scores of critical thinking skills among experimental class students who studied with using audiovisual media on the topic "Mold", and control class students who studied using PPT learning media. The results of the N-Gain score analysis are described in Table 3. The N-Gain Percent value of students' critical thinking skills was continued with statistical analysis using the Independent Sample t Test which was preceded by a normality assumption test. The normality test results are described in Table 4. It can be seen that the Sig. for N-Gain Percent on critical thinking skills of Sig. 0.000 > 0.05, it can be concluded that the data is not normally distributed, and can't be continued with the Independent Sample t Test.

Therefore, another alternative test was carried out, namely the Mann Whitney test for non-parametric statistical analysis. The results of the Mann Whitney test are described in Table 5. It is known that the comparison of critical thinking skills between the experimental class and the control class has a value of Sig. equal to 0.022 < 0.05. This proves that the hypothesis is accepted. There is a significant difference in students' critical thinking skills between the experimental class which is taught using audiovisual media on the topic "Mold" and the control class which is taught using PPT media. This indicates that experimental class students have higher critical thinking skills scores compared to the control class.

This research and development has proven that audiovisual media on the topic "Mold" is

proven to be effective in improving critical thinking skills, compared to control class students who use PPT as learning media. This finding was also reported by Kahfi et al. (2021), Salsabila et al. (2020), Pratiwi (2022), Vera & Wardani (2018), Soedarnadi & Sulisworo (2021), Kurniati et al. (2019), and Soedarnadi & Sulisworo (2022).

The results of the analysis in this research and development show that the percentage value of the N-Gain score for critical thinking skills in the experimental class is 79% in the effective category, while in the control class it is 41% in the less effective category. Evidence of the results of this implementation is also strengthened by the results of non-parametric statistical tests, namely the Mann Whitney test which obtained a Sig value. equal to 0.022 < 0.05, which means the hypothesis is accepted. There is a significant difference in critical thinking skills between experimental class students who are taught using audiovisual media on the topic "Mold" based on Guided Inquiry and control class students who are taught using conventional PPT learning media.

Based on the N-Gain Percent ranking value or Mean Rank of the two classes, it can be seen that the ranking value of the experimental class is 35.88 higher than the control class of 26.27. This indicates that experimental class students have higher critical thinking skills scores compared to the control class. This is because learning using audiovisual media on the topic "Mold" provides students with the opportunity to be able to learn independently and freely without being limited by space and time during the learning process, lecturers have accompanied students in carrying out learning and practicum activities. Experimental class students can also be more active in searching

for information, finding solutions, and can discuss in groups to complete assignments presented in audiovisual media on the topic "Mold". Learning using PPT in control classes is less effective because students are limited by time in learning. According to Kamil (2019) PPT media has weaknesses, namely: 1) PPT can't be used to present all material; 2) An interesting PPT requires special skills for its users, so that the PPT presented makes it easier for the audience to receive information; and 3) users who add graphic designs such as animation to PPT need a long preparation time to create complex PPT.

Based on the results of a student needs analysis questionnaire conducted by researchers on January 9th 2022, it shows that students stated that they 100% needed to make audiovisual media on mold material because according to students, if they used audiovisual media they could understand students better, especially in today's online-offline learning. Based on the pictures of plants attacked by fungi in the needs analysis questionnaire, students stated that it was 100% necessary to make visual media, because it could make it easier for students to understand why leaves can be infected by mold. Students stated that 87.5% of them needed voice narration, because every student is able to see pictures, but not necessarily able to understand the meaning of the picture, so having voice narration will certainly make it easier for students to understand the material. The following are statements from students about why audio is needed: 1) because the lecturer can explain the process of mold infection on leaves (81.3%); 2) through voice narration, students can understand leaves damaged by mold activity (56.3%); 3) to attract students' attention (43.8%); 4) can help students understand the material not only visually, but also audio (81.3%); and 5) can provide meaningful lectures with the presence of audiovisual media on mold material (56.3%).

According to students, the media that is more needed and more efficiently used in lectures today is audiovisual media (93.8%) and visual media (6.2%). Based on the picture shown in the needs analysis questionnaire about "Microscopic Structure of the Mold *Rhizopus oryzae*", 100% of students agreed that it would be best to use pictures accompanied by narration. 100% of students agree with the presence of audiovisual media in learning Microbiology in the "Mold" material. Based on the facts in the form of students' statements that they need audiovisual media to help in the Microbiology learning process, especially on the topic "Mold", the researchers conducted research on the use of audiovisual media

to help students better understand the concept of mold structure with the help of lecturers.

Based on the results of the lecturer needs analysis questionnaire conducted by researchers on December 29th 2021, it shows that the respondent lecturers agree that audiovisual media is more needed and more efficient when used in current online-offline lectures. According to the lecturer, it is necessary to create audiovisual media on the "Mold" material, because it is easier for students to understand. Lecturers also agreed to make visual media, because it was easier for students to understand the concept of plant infection by mold. According to the lecturer, there also needs to be voice narration, because with voice, the concepts will be easier for students to understand. The following is the lecturer's opinion on why audio is needed: 1) so that students can understand leaves damaged by mold; 2) to attract students' attention; and 3) can help students understand the material not only visually, but also audio. The lecturer also agreed that the pictures were equipped with narration, and the lecturer stated that he agreed with the presence of audiovisual media in learning Microbiology in this "Mold" material. There are two types of audiovisual media commonly used in learning, namely: 1) pure (dynamic) audiovisual media; and 2) impure (static) audiovisual media (Manshur & Ramdlani, 2020). Pure audiovisual media or what is usually called dynamic audiovisual media is moving media, such as: television, film and video (Nurani et al., 2018). The audiovisual media created by researchers is static audiovisual media, meaning it doesn't move. Narration is provided to clarify the appearance of the mold image. Researchers have conducted research on "Isolating Mold from Pastries" to ensure that mold can grow on pastries. Photos of colonies and microscopic photos of mold from dry cakes were used to complement the audiovisual media photos made.

D. Conclusion

Based on the results of this research, it can be concluded that audiovisual media on the topic "Mold" based on Guided Inquiry regarding "Techniques for Using Microscopes, Description of Colony Morphological Characteristics, and Microscopic Mold" is declared effective in improving students' critical thinking skills, so that it can be used in learning Microbiology. For other researchers, it is recommended that through the results of this research, other researchers can conduct similar research regarding the development of audiovisual media on the different materials and on different skills.

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