

# Developing Multimedia with STEM Education in University: Needs Analysis in Microbiology Learning

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**Abstract.** The Microbiology learning at the Department of Biology Education IKIP Budi Utomo not used learning media that integrates digital, technology, and humans to help students understand the concept of microbiology. The purpose of this study was to determine the responses of students and lecturers to multimedia with STEM education (M-STEM) in microbiology learning. The research method is a quantitative descriptive research method through survey techniques with a sample of 43 students and 4 microbiology lecturers at the Department of Biology IKIP Budi Utomo. The research instrument was a questionnaire consisting of 40 questions for students and 25 questions for lecturers. The results showed that students strongly agreed to use multimedia (62.8%), students were more interested in multimedia (25.6%), students rarely use STEM education (60.5%), students agree that microbiology learning uses the STEM education (58.1%), students are very interested in multimedia with STEM education (90.7%), students agree that multimedia with STEM helps them to understand the concept of microbiology (58.1%), lecturers strongly agree to use the STEM education (100%), and lecturers strongly agree to use multimedia (100%). This study concluded that students and lecturers need M-STEM in microbiology learning at the Department of Biology Education IKIP Budi Utomo.

**Keywords:** Microbiology learning; multimedia; STEM.

## INTRODUCTION

Higher Education must use new literacy such as digital, technology, and human for learning in the era of industrial revolution 4.0 (Kemenristekdikti, 2018). Digital literacy is used to analyze and use information (big data) in the digital world. Technological literacy is used to master the workings of machines and the application of technology. Human literacy is used to live well in society. The era of RI 4.0 urges that learning is not enough with old literacy so it is necessary to find strategies to develop student cognitive capacity (Ahmad, 2018). Educators like lectures must have high competence to stimulate the development of student abilities (Wahyuni, 2018; Yumnaini & Slamet, 2019). Student competencies that must be prepared are the 21st century like innovations and skills such as critical thinking, creativity, collaboration, and communication (Hermana, 2019; Zubaidah, 2018).

One of the many strategies that can empower students' 21st-century skills is the use of learning media such as multimedia (Hidayati & Irmawati, 2019; Hidayati, Irmawati, & Prayitno, 2019). Multimedia can combine text, audio, video, internet, and computer devices as well as support for more dynamic learning (Almara'beh, Amer, & Sulieman, 2016). The use of learning media such as multimedia not only helps students understand the concept of the material but also provides meaningful learning experiences for students (Aflalo & Gabay, 2013). In multimedia with STEM (Science, Technology, Engineering, and Mathematics) education, there is a worksheet that contains learning with STEM education. The content of the worksheet shows eight STEM education activities, including defining problems, connecting with real-life, planning and conducting investigations, analyzing and interpreting



data, making a temporary conclusion, designing alternative problem solving, discussing solutions obtained, and evaluating and communicating (Hidayati & Irmawati, 2019; Hidayati et al., 2019). Bybee (2011) argues that these eight steps of STEM education will motivate students to plan, investigate, engineer, interpret data, think critically, innovate, create, and collaborate.

The results of observations in microbiology learning in the Department of Biology Education, IKIP Budi Utomo show that microbiology learning has not used learning media that integrates digital, technology, and humans to help students understand the concept of microbiology. These three literacies are very important in microbiology learning because with these three literacies students can study anywhere and anytime without having to meet face to face with lecturers. In addition, learning must be supported by technology by the demands of the curriculum of the department of biology education at IKIP Budi Utomo. Students seem lazy to learn microbiology, students are less active in learning because they have not used approaches and models that involve students, students are less enthusiastic in learning because they only listen to presentations from lecturers and friends using PowerPoint media. Furthermore, multimedia that has been used in microbiology learning only contains material text without integrated approaches, worksheets that will activate students in learning, mini lab activities, and tests (Prayitno & Hidayati, 2017).

The development of teaching materials in microbiology learning such as media and material from previous research has not carried out a needs analysis of the importance of developing teaching materials. The results of research by Prayitno & Hidayati (2017) have not explored the problems that exist in microbiology learning optimally. Here, it only focuses on the existence of teaching materials, student attitudes during presentations and discussions, and the use of IT in learning. Research Arifin & Lestari (2020) shows that it does not carry out a needs analysis in developing multimedia so that the resulting products have not optimally resolved problems in microbiology learning. But in this study, researchers explored optimally the problems that occur in microbiology learning including curriculum analysis, analysis of the learning process, analysis of media use, analysis of the suitability of media to the curriculum and student characteristics, analysis of student attractiveness in learning media, and analysis of the level of material difficulty learning. Based on the description above, the purpose of this research was to determine the responses of students and lecturers to multimedia with STEM education (M-STEM) in microbiology learning. The use of multimedia with STEM education in microbiology learning needs to be explored more deeply through this survey technique. This research can be used as a reference by lecturers, especially in the Department of Biology, IKIP Budi Utomo to develop learning media such as multimedia with STEM education so that can make a real contribution to microbiology learning.

## METHOD

The research method used is descriptive quantitative research methods through survey techniques. The research sample was 43 students who have studied microbiology and four microbiology lecturers at the Department of Biology Education, IKIP Budi Utomo. The research instrument was a questionnaire consisting of 40 questions for students and 25 questions for lecturers. The research instrument was made by the researcher with google form and validated by an education expert lecturer at the Department of Biology Education, IKIP Budi Utomo. The research instrument is valid and eligible for use in the collection of research data. The contents of the instrument include the aspect of curriculum, learning process, media use, the suitability of media to the curriculum and student characteristics, student attractiveness in learning media, and the level of material difficulty learning. The research data collection technique uses a questionnaire such as a google form consisting of 40 questions given to 43 students via WhatsApp group and 25 questions given to four lecturers via personal messages. On the google form, the research data has been analyzed automatically and the results immediately come out in the form of a percentage. Furthermore, the data of research are the percentage of student and lecturer responses which were analyzed descriptively.

## RESULT AND DISCUSSION

The results of the student response survey on M-STEM in microbiology learning are presented in **Table 1**. Furthermore, the results of the lecturer response survey on M-STEM in microbiology learning can be seen in **Table 2**.



TABLE 1. The Results of Student Response Survey on M-STEM in Microbiology Learning

No	Items	Response (%)	Description
1	The lecturer provides the Semester Lesson Plan (SLP)	88,4	Always
2	Learning media is needed in microbiology learning	60,5	Strongly agree
3	Printed teaching materials used in microbiology learning	53,5	Textbooks
4	Non-printed teaching materials used in microbiology learning	30,2	Multimedia
5	Learning media by microbiology learning	62,8	Multimedia
6	The material in multimedia that has been followed in microbiology learning	25,6	On topic
7	Microbiological material that is considered difficult	62,8	Characteristics and classification of microorganisms
8	The existence of student worksheets, practicum procedures, and evaluation questions on microbiology learning media	76,7	Available
9	The content of microbiology learning media commonly used	74,4	Concept of microbiology material
10	Interest in microbiology learning media	25,6	Multimedia
11	Source of learning media	53,5	Lecturer
12	Source of non-printed teaching materials	58,1	Lecturer
13	The form of microbiology learning media	76,7	Only the concept of microbiology material
14	Multimedia forms that have been used in teaching microbiology	76,7	Only the concept of microbiology material
15	Multimedia content that has been used in microbiology learning	69,8	Only material text
16	Availability of evaluation questions in the printed media	79,1	Available
17	Multimedia containing evaluation questions and live scores	60,5	Never
18	The suitable media for online learning in microbiology learning	67,4	Multimedia
19	The media content that should be used in microbiology learning	69,8	Not only text material but student worksheets, evaluation questions, videos, audios, practicum procedures, and ebook
20	Learning media can show the live score of the evaluation	53,5	Strongly agree
21	Experience using learning media that shows the live score of the evaluation	16,3	Very rarely
22	An online evaluation form for online microbiology learning	65,1	Agree
23	The learning model used in microbiology learning	58,1	Problem-based learning
24	The need for a learning model in microbiology learning	100	Cooperative learning model
25	The preferred microbiology learning activities	46,5	Group and others



26	The preferred activity when the microbiology learning process takes place	32,6	Work on student worksheets
27	The preferred activities during microbiology learning	74,4	Solving the problems related to material
28	Experience learning with the STEM education	60,5	Rarely
29	Using of STEM education in microbiology learning	58,1	Agree
30	Microbiology learning activities that include problem-solving, creativity, and providing solutions	65,1	Agree
31	Microbiology learning so far	62,8	Face to face and online
32	An interesting and contemporary learning model in microbiology learning	60,5	Frequently
33	Multimedia with STEM education in microbiology learning	37,2	Never
34	Microbiology learning with STEM education	60,5	Agree
35	Interesting in learning microbiology with multimedia with the STEM education model	90,7	Interested
36	Learning microbiology with multimedia based on the STEM model makes it easier to understand the concept of microbiology material	58,1	Agree
37	The form of abilities developed in microbiology learning	62,8	Cognitive
38	The level of difficulty of the microbiological evaluation questions	53,5	Difficult
39	The form of microbiology learning questions	62,8	Problem solving and application in life
40	Interesting online microbiology learning	39,5	WA group

Table 1 shows that 62.8% of students strongly agree to use multimedia (item 5), 25.6% of students are more interested in multimedia (item 10), 60.5% of students rarely use STEM education (item 28), 58.1% of students agree in microbiology learning using the STEM education (items 29 & 34), 90.7% of students are interested in multimedia with STEM education (item 35), and 58.1% of students agree that multimedia with STEM education helps in understanding the concept of microbiology (item 36). Based on the research findings above, learning media such as multimedia are needed by students to help them in microbiology learning. Multimedia as a learning media can make the learning process more oriented towards learning outcomes, more effective learning, make it easier to provide information to students, and can increase collaboration between teachers and students (Almara'beh, Amer, & Sulieman, 2016; Hidayati & Irmawati, 2019; Kaur, Sharma, & Singh, 2015). Multimedia used in learning can help improve students' understanding of the concept of the material taught by the lecturer (Apriyanti, Nur, Rahim, & Shaharom, 2017; Kareem, 2018).

In addition, the student response to M-STEM shows that the form of microbiology learning media which not only contains material text but student worksheets, evaluation questions, videos, audios, practicum procedures, ebook, and live score. Hidayati & Irmawati (2019) argue that effective and interesting multimedia is multimedia that contains learning outcomes, text material, pictures, video, audio, worksheets based on learning model or approach, ebooks, evaluation questions, and live scores. Some researchers explain that effective multimedia is multimedia that is easily accessed by students anywhere and anytime with a smartphone and can help students understand the concept of the material so that learning outcomes can be achieved (Apriyanti et al., 2017; Kareem, 2018; Xu, 2017; Serbezova, 2019). Ahmed et al. (2020) argue that a smartphone that can be used to access multimedia anywhere will make it easier for students to learn and understand the concept of the material provided by the lecturer. Furthermore, students are interested in multimedia based on STEM because they hope multimedia based on STEM can help students to understand the concept of material, make a plan, investigate, engineering, interpret data, think critically, innovate, create and collaborate. STEM learning integrated into multimedia can motivate students to investigate, engineering, innovate, interpret data, and improve critical thinking (Bybee, 2011; Kennedy & Odell, 2014; Hidayati, Irmawati, & Prayitno, 2019; Hidayati & Irmawati, 2019).



The Semester Lesson Plan (SLP) provided does not accommodate the learning process by the demands of 21st-century education and the curriculum used, the learning process is dominated by presentation discussions. The learning media used so far are only printed teaching materials in the form of modules or handouts, even though at this time, flexible learning media are needed and can be accessed anywhere and anytime such as multimedia forms. Microbiology learning needs the help of learning media because according to students there is a lot of material that they find difficult but the learning media available is only one topic. This has become one of the fundamental problems of microbiology learning. Good learning media will be one of the factors in achieving the learning process as stated in the desired learning outcomes (Hidayati, Pangestuti, & Prayitno, 2019).

So far, the learning media used during learning is always provided by the lecturer, but there are several weaknesses, namely, there is only one material topic that is equipped with student worksheets and practicum activities, most of the media only contains learning material. To be able to develop students' higher-order thinking skills, the learning process carried out must also reflect activities that empower thinking abilities. Good learning media must accommodate learning activities in the classroom to be able to activate students' thinking abilities and skills in understanding concepts (Prayitno & Hidayati, 2020). A learning approach is needed that can accommodate the learning process that can foster students' thinking skills, one of which is the STEM approach (Hidayati & Irmawati, 2019).

The many desires of students with the availability of multimedia in learning are one of the things that need to be considered by lecturers. So far, students have never used learning media which is integrated with the interactive type of evaluation. The existence of an interactive evaluation form is one of the benchmarks for students independently to find out their level of understanding of the material and demands student readiness in studying the material in lectures. The form of evaluation in multimedia will be able to facilitate learning both in-person and online. Questions on evaluation must be developed concerning higher-order thinking skills to accurately measure student abilities (Hidayati & Irmawati, 2019; Prayitno & Hidayati, 2020; Hidayati & Irmawati, 2020).

The test questions that are currently being done by students are very difficult for students. One of the things that affect is that students are not taught to hone higher-order thinking skills, but the form of questions given is at the HOTS level so that students will not be able to achieve the targets given by the lecturer. Therefore, it is necessary to support learning media that accommodate learning activities that empower students' thinking abilities to achieve the expected learning objectives (Hidayati, Irmawati, et al., 2019). One of the approaches used to empower students' abilities is to use STEM (Bybee, 2011; Kennedy & Odell, 2014; Hidayati & Irmawati, 2019). STEM education in the classroom can be broken down into eight stages including defining problems, connecting with real-life, planning and conducting investigations, analyzing and interpreting data, making a temporary conclusion, designing alternative problem solving, discussing solutions obtained, and evaluating and communicating (Bybee, 2011; Hidayati & Irmawati, 2019). STEM education can stimulate students to improve their 21st-century skills (Hidayati, Irmawati, et al., 2019; Jauhariyyah, Suwono, & Ibrohim, 2017).

TABLE 2. The Results of Lecturer Response Survey on M-STEM in Microbiology Learning

No	Items	Response (%)	Description
1	The learning model used during microbiology learning	75	Cooperative learning
2	The argument uses a cooperative learning model	75	By the condition of student character
3	The condition of students while participating in microbiology learning with a cooperative model	75	Enthusiastic
4	The learning model used when online microbiology learning	25	Cooperative model
5	The reasons for using cooperative models when online microbiology learning	50	Flexible according to the situation
6	Student conditions when studying with a cooperative model during online learning	75	Well
7	The impact of online microbiology learning for students	75	Learning continues even though we don't meet the lecturer
8	A learning model that is suitable for online microbiology learning	50	Cooperative models such as PjBL and PBL



9	Microbiology learning process using the STEM education	75	Never
10	Microbiology learning with the STEM education	100	Agree
11	Microbiology materials that are considered difficult to be mastered by students	50	Characteristics and classification of microorganisms
12	Microbiology learning using print media	100	Using print media
13	Microbiology learning arguments by utilizing print media	100	Easily accessible
14	Microbiology learning with multimedia	50	Never yet
15	The form of teaching materials suitable for microbiology learning in the new era	50	Multimedia
16	The readiness of students to use multimedia when studying microbiology	100	Ready
17	Teaching material content includes Learning Outcomes (LO), student activities, materials, and evaluation questions	50	Never yet
18	Multimedia is suitable for microbiology learning	100	Strongly agree
19	Student skills are measured in microbiology learning	100	HOTS (Higher Order Thinking Skills)
20	How to develop student HOTS	100	Using learning media
21	Student skills that need to be developed	50	21st-century skills such as Critical thinking and communication skills
22	Microbiology Learning develops critical thinking and communication skills	50	Never yet
23	Critical thinking and communication skills need to be developed in microbiology learning	100	Agree
24	The form of microbiology learning that supports the development of student's critical thinking and communication skills	50	Student center with a cooperative model
25	A way to develop students' critical thinking and communication skills in microbiology learning	50	Problem-solving

Based on Table 2, show that 100% of lecturers agreed to use the STEM model in microbiology learning (item 10), 100% of lecturers gave answers that students were ready to use multimedia (item 16), and 100% of lecturers strongly agreed to use multimedia in microbiology learning (item 18). STEM education provides opportunities for students to integrate interdisciplinarity such as science, technology, engineering, and mathematic in microbiology learning so that student skills can be developed. Fajrina, Lufri, & Ahda (2020), and McDonald (2016) argue that STEM learning can enhance students' 21st-century skills. Students' 21st-century skills can enhance with STEM learning is critical thinking skill (Hidayati & Irmawati, 2019; Hidayati et al., 2019). Students are very ready to use multimedia based on STEM (M-STEM) because all students have smartphones that can be used to access this multimedia. Smartphones help students in the learning process (Ahmed et al., 2020; Morris & Lambe, 2017). Lecturers strongly agree to use multimedia because multimedia can integrate digital and system technology so that it can contain material text, images, video, audio, worksheets based on learning model or approach, mini lab, mini quiz, evaluation questions, and live score. Thus, multimedia can increase student interest in learning (Wang, Sun, & Li, 2019; Zhang, 2005).

In addition, learning that is commonly used in microbiology learning is to use a cooperative approach but not all learning materials, only on one to three material topics. The learning process is mostly carried out by discussing presentations seen in SLP, the media used, and worksheets. The learning process which tends to be only a presentation discussion will make it difficult for students to answer the questions presented in each item of the question given at the end of the material because the questions developed are at a higher level than what is being learned. So it is necessary to improve the learning process through integrated learning media with learning approaches to empower students' higher-order thinking skills (Hidayati & Irmawati, 2019; Abdurrahman, 2019).



The availability of multimedia that integrates approaches, practicum activities, and interactive evaluation does not yet exist and this is following the results of filling out questionnaires by students. Multimedia is one of the factors that can improve the learning process and quality to produce students who can master higher-order thinking skills. Multimedia that reflects the STEM approach is expected to be able to empower students' thinking skills by integrating concepts with technological developments (Hidayati & Irmawati, 2019; Hidayati, Irmawati, et al., 2019; Widayanti, Abdurrahman, & Suyatna, 2019). Based on the data that has been obtained from both student and lecturer questionnaires, it can be said that the availability of learning media that is following the curriculum and student characteristics does not exist. The results of this analysis are very useful in the preparation of learning media, especially in microbiology learning because identifying existing problems can be used as a measure for which parts must be improved so that the learning media developed is following the achievement of learning objectives.

## CONCLUSION

The students and lecturers need multimedia with STEM education (M-STEM) in microbiology learning at the Department of Biology, IKIP Budi Utomo. Furthermore, the results of this research are recommended to be used as a strong basis to developing multimedia with STEM education in microbiology learning (M-STEM) which can empower students' 21st-century skills through the Research and Development (R&D) method. The recommended multimedia with STEM education includes learning outcomes, text materials, images, videos, audio, mini-quizzes, mini labs, worksheets with STEM education, tests to empower 21st-century student skills, and scores that can be seen in real-time.

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