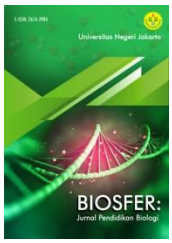
Biosfer: Jurnal Pendidikan Biologi, 18(1), 243-254 (2025)

Biosfer: Jurnal Pendidikan Biologi

Journal homepage: http://journal.unj.ac.id/unj/index.php/biosfer



Chatbot-autoreply for virus topics to strengthen the profile of pancasila students with critical thinking and creativity

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ARTICLE INFO

Article history
Received: 28 October 2024
Revised: 18 December 2024
Accepted: 25 December 2024

Keywords:
Critical Thinking.
Creativity.
Learning Media.
Society 5.0.
Virus.

ABSTRACT

The Society 5.0 era demands the younger generation to possess a Pancasila student profile. WhatsApp-based chatbot learning media can be a solution to enhance understanding of virus materials and strengthen such a profile. This research develops a chatbot autoreply-based learning media called SIMBBIOSIS (*Sistem Integrasi Media Belajar Biologi Seru, Informatif, dan Sistematis*), focusing on virus materials in phase E. SIMBBIOSIS is designed to provide engaging information and interactions, as well as encourage students to think critically and creatively in solving virus-related problems. The research employs the Research and Development (R&D) method using the ADDIE development model, which consists of five stages: analysis, design, development, implementation, and evaluation. The R&D process resulted in the creation of SIMBBIOSIS, a WhatsApp-based chatbot autoreply learning media. SIMBBIOSIS was designed to address the challenges of fostering critical thinking and creativity among students. During the implementation phase, the media was tested on students at MAN 3 Cirebon, with class X.9 serving as the experimental group and X.11 as the control group. The findings of this research indicate that the SIMBBIOSIS learning media effectively improved students' critical thinking and creativity. The critical thinking dimension showed significant improvement, as evidenced by an N-Gain of 82.35% and the SPSS paired T-test result of $0.0 < \alpha$ (0.05). In terms of creativity, the experimental group produced more varied and innovative virus-related educational media compared to the control group, reflecting an enhancement in their ability to think creatively.

INTRODUCTION

The "Indonesia Emas 2045" program is a government-initiated program aimed at making Indonesia a prosperous and advanced country by 2045. The program is based on four main pillars: human development and mastery of science and technology, sustainable economic development, equitable development, and strengthening national resilience and governance (BAPPENAS, 2019). The implementation of this program is based on the fact that by 2045, Indonesia will experience a demographic bonus. This demographic bonus means that by 2045, 70% of Indonesia's population will be of productive age (15-64 years) (Puspa et al., 2023). This can benefit Indonesia in many ways, especially economically, provided that the program is well-prepared and implemented. To prepare for this, the government is implementing a new curriculum called the Merdeka Curriculum. This curriculum is expected to prepare today's students to meet future challenges and realize the goals of the Indonesia Emas 2045 Program (Suharjo & Jacky, 2023)

To achieve the first pillar of the Indonesia Emas 2045, namely human development and mastery of science and technology, the younger generation must first be able to adapt to and address the challenges of the ongoing Society 5.0 era (Pristiwati, 2023). The Society 5.0 era is characterized by the integration of physical and digital spaces, where advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), and big data are used to create a more inclusive, efficient, and sustainable society (Narvaez Rojas et al., 2021). In Society 5.0, technology is not only used to improve economic efficiency but also to solve social problems and enhance the quality of life for everyone. This era prioritizes the balance between technological advancement and human values, aiming to create harmony between technological progress and human social needs (Tavares et al., 2022). Society 5.0 is an evolution from Society 4.0, which focused more on digitization and automation, towards a more human-centered society where technology is used to meet the broader needs of individuals and society (Kasinathan et al., 2022)

The Merdeka Curriculum is the right solution to prepare the young generation of Indonesia to face these two challenges. The Merdeka Curriculum is designed to improve the quality of education and the competitiveness of Indonesian human resources to be on par with other countries, in line with the Sustainable Development Goals (SDGs) to enhance inclusive and equitable quality education. In facing the Society 5.0 era, where rapid technological advancement impacts all aspects of life (Yamanishi, 2018), the Merdeka Curriculum emphasizes developing students' character and competencies that align with contemporary challenges (Egistiani, 2022). This includes enhancing creativity, critical thinking, communication, and collaboration (4C), which are crucial for addressing the challenges in the Society 5.0 era. Therefore, the Merdeka Curriculum is considered to offer a comprehensive educational approach that not only prepares students with high academic and technical skills but also with strong character and moral values. This is key in preparing the younger generation to contribute positively to sustainable development and face the challenges of Society 5.0 and the SDGs (Hersusetiyati & Chandra, 2022).

The implementation of the Merdeka Curriculum is regulated by the Keputusan Pendidikan, Kebudayaan, Riset, Dan Teknologi Republik Indonesia Number 5 of 2022. This curriculum prioritizes the development of essential skills and character alongside academic knowledge. It was introduced in several educational units in 2022 and began to be implemented nationally in 2024. Currently, 293,373 educational units have implemented the Merdeka Curriculum. In West Java province alone, 36,301 educational units, or about 57%, have already implemented the Merdeka Curriculum (Kemendikbudristek, 2022a). This curriculum differs from previous methods by providing greater flexibility to teachers in designing learning tailored to the specific needs of students and the local context. The Merdeka Curriculum emphasizes project-based learning, encouraging students to actively engage with the material, thus promoting critical thinking, collaboration, and problem-solving skills (Yasykur et al., 2023). This shift in focus aims to produce well-rounded individuals equipped not only with academic knowledge but also with the skills necessary to thrive in the 21st century. The Merdeka Curriculum emphasizes the development of students' character and competencies in line with the challenges and needs of the Society 5.0 era, which is marked by rapid and global technological advancements (Bungawati, 2022). The implementation of Merdeka Curriculum is closely related to the Profile of Pancasila Students. The Merdeka Curriculum emphasizes character building in students, with one of its policies being the formation of character based on the Profile of Pancasila Students (Iskandar et al., 2023). The Profile of Pancasila Students is integrated into the Merdeka Curriculum as a

formulation of national educational values, authorized by the President of the Republic of Indonesia through the Minister of Education and Culture Regulation Number 20 of 2018. This demonstrates the direct link between the Profile of Pancasila Students and the Merdeka Curriculum in shaping students' character according to Pancasila values (Purnawanto, 2022).

The Profile of Pancasila Students embodies the national education goals in Indonesia. The Merdeka Curriculum addresses the challenges of Society 5.0 by providing educational innovations that focus on deepening the character of students based on the Profile of Pancasila Students, which includes six dimensions involved in strengthening this profile. The aim is to create students who not only master science and technology but also possess good character and morals, which are essential in facing the challenges of Society 5.0. The dimensions of the Profile of Pancasila Students are outlined in the BSKAP Kemendikbudristek Decree No. 9 of 2022. Based on these considerations, it is explained that the Profile of Pancasila Students consists of six dimensions. These dimensions are crucial in developing the profile of Pancasila Students, religius character (faith, piety to god almighty, and noble character), independence, cooperation, global diversity, critical thinking, and creativity.In this study, the dimensions to be measured are limited to critical thinking and creativity (Kemendikbudristek, 2022a).

The strengthening of the Pancasila Student Profile will focus on three dimensions: The critical thinking dimension of Pancasila Student Profile within the Merdeka Curriculum includes students' ability to process information and ideas objectively, both qualitatively and quantitatively. Students with critical thinking skills are able to link information, analyze and evaluate them, and arrive at well-reasoned conclusions (Supriyatno et al., 2020). Critical thinking involves gathering and interpreting information and ideas, assessing and analyzing reasoning, and reflecting on thought processes and decision-making (Rosmalah et al., 2022). The creativity dimension of the Pancasila Student Profile in the Merdeka Curriculum highlights students' capacity to generate innovative ideas and transform them into unique actions and creations. These students exhibit flexible thinking, enabling them to explore alternative solutions to challenges. They are adept at making decisions when presented with multiple options to address problems. Furthermore, creative students can evaluate and compare their ideas, actively seeking new approaches if their initial methods are unsuccessful. They also demonstrate adaptability by experimenting with various strategies in response to shifting circumstances and conditions (Kemendikbudristek, 2022b).

In the Merdeka Curriculum, the levels of learning materials are divided into six phases, with each phase containing specific learning achievements for each subject. At the senior high school level, grade X is part of phase E. The virus material is included in phase E in the Biology subject, making it one of the first materials encountered by students transitioning from junior high school to senior high school (BSKAP, 2022). The virus material is also one of the difficult materials to understand due to its high-level concepts, and it is not easy for students to grasp since observing viruses directly requires special equipment not available in most schools (Firmanshah et al., 2020). Based on the above explanation, it can be concluded that a digital learning medium is needed to fully explain the concept of viruses and strengthen or enhance the Pancasila Student Profile in the dimensions of critical thinking and creativity. Therefore, the author has created a digital learning medium based on a chatbot-autoreply system on the WhatsApp application. This system is named SIMBBIOSIS.

A chatbot-autoreply feature allows users to create automatic reply messages that will be sent in response to received messages when they are inactive or unable to answer directly. This feature is useful for accessing information on the chatbot-autoreply at any time, even outside of working hours (Ramadhan et al., 2020) This allows students to access lessons even outside school hours, making this medium both a learning tool and a fun, interactive, and systematic supplementary learning medium. The SIMBBIOSIS medium is equipped with various features that support teaching and learning activities, such as Augmented Reality, Interactive Videos, Games, and interactive assessments using the Quizizz platform. Augmented Reality (AR) technology combines the virtual and real worlds, allowing users to see the real world enhanced with virtual elements. The display in Augmented Reality allows students to observe objects in 3D, which will undoubtedly make it easier for them to understand the structure of viruses interactively (Namdzulhajjri et al., 2023)

METHODS

Research Design

This study employed the Research and Development (R&D) method with the ADDIE development model, which consists of five stages: analysis, design, development, implementation, and evaluation.

1. **Analysis Stage (Analyze)**
   At this stage, learning needs were identified. It was found that teachers require technology-based media to facilitate an interactive understanding of virus materials while helping students develop critical thinking and creativity.
2. **Design Stage (Design)**
   The researcher designed an e-module learning media based on a chatbot-autoreply system accessible via WhatsApp. This media presented virus materials in the form of text, images, videos, and voice messages and included an interactive chatbot feature to support students' independent learning
3. **Development Stage (Development)**
   The developed learning media was validated by material and media experts. Validation included the alignment of materials with the syllabus, completeness of content, design aesthetics, and technical aspects such as color combinations and font types (Fadhli, 2023). Based on feedback from validators, revisions were made until the media was deemed suitable for testing.
4. **Implementation Stage (Implementation)**
   After the validation and refinement processes, the finalized learning media was implemented in the experimental class. The experimental group used the chatbot-autoreply-based learning media, while the control group employed conventional teaching methods.
5. **Evaluation Stage (Evaluation)**
   Evaluation was conducted using a quasi-experimental approach, involving pre-tests and post-tests to assess the improvement in students' critical thinking and creativity skills. The study population consisted of students from MAN 3 Cirebon, with a sample of two classes: X.8 and X.9. Class X.8 served as the experimental group, while Class X.9 acted as the control group. The research was conducted between March and April 2024.
   The pre-test and post-test data were analyzed to measure the effectiveness of the learning media. Additionally, a student satisfaction survey was conducted to gather feedback on the chatbot features and its contribution to understanding virus materials.

Population and Samples

The population for this study consisted of students from MAN 3 Cirebon. The sample included two classes, X.8 and X.9, selected as the research subjects. One of these classes was designated as the experimental group, while the other served as the control group. The research was conducted between March and April 2024

Instrument

The instruments used in this study included SIMBBIOSIS teaching media for the experimental group and traditional teaching methods for the control group. To assess the validity of the SIMBBIOSIS media, two key aspects were evaluated: the material component and the media component. Additionally, a Higher-Order Thinking Skills (HOTS) test was used to evaluate students' critical thinking regarding virus-related topics. A creativity assessment rubric was also used to evaluate students' creativity in the experimental group, focusing on originality, flexibility, and elaboration in their responses to virus-related materials.

Procedure

The research followed ADDIE Model. This development model, includes five stages of development: analysis, design, development, implementation, and evaluation. During the study, the experimental group engaged in learning activities using SIMBBIOSIS media, while control group received instruction through the classical method learning. Data collection and evaluation took place during the implementation phase, covering the period from March and April 2024.

Data Analysis Techniques

The data analysis for this research was conducted using SPSS 27 software. To measure the improvement in student learning outcomes, the N-Gain test was employed. The validity of the data was assessed using the Kolmogorov-Smirnov test to ensure normality. In addition, a paired t-test was applied to analyze paired data within each group, providing insight into changes before and after the intervention. Creativity was assessed based on the originality, flexibility, and problem-solving aspects demonstrated in the student-created educational media. This combination of tests allowed for a comprehensive evaluation of the effectiveness of SIMBBIOSIS media in enhancing both learning outcomes and creativity in students.

RESULTS AND DISCUSSION

The Research and Development (R&D) research method involves five stages that must be completed to develop the SIMBBIOSIS learning media. The following is an analysis of the research results divided into the five R&D stages (Spatioti et al., 2022):

1. Analysis Stage

This initial stage aims to identify existing problems and create an appropriate solution plan. In determining the problem, the researcher conducted a curriculum analysis, an analysis of student needs, and an analysis of available resources. The curriculum analysis revealed that the Merdeka Curriculum aims to develop students who are not only intelligent but also have strong character in accordance with Pancasila values. Thus, a learning medium that can stimulate and strengthen the Pancasila Student Profile based on its dimensions is needed. The curriculum analysis also indicated that the virus material is quite abstract and requires more detailed modeling and visualization to help students understand it better (Amini, 2023). The analysis of student needs highlighted the challenges of the Society 5.0 era, requiring learning media closely linked with technology to help students adapt to digitalization. The resource analysis showed that not all schools have virus models or teaching aids. Therefore, creating digital virus models would significantly aid learning activities. Many students bring smartphones to class, making it feasible to use digital media for learning.

2. Design Stage

The design stage for the SIMBBIOSIS learning media is divided into two main phases:

A. Outline SIMBBIOSIS

SIMBBIOSIS utilizes a WhatsApp chatbot auto-reply as its platform. This requires designing the systematic structure of the WhatsApp chatbot auto-reply using a spreadsheet, including welcome text, input text, and output text.

B. Content SIMBBIOSIS

In this phase, the researcher designs the content for the SIMBBIOSIS media. This content includes core material, augmented reality modeling, interactive videos, a virtual laboratory, assessments, games, and Google Drive for task submissions.

3. Development Stage

At this stage, the SIMBBIOSIS learning media undergoes a thorough validation process to assess its feasibility. This validation is conducted by expert biology teachers and information technology teachers, who evaluate both the content of the material and the design and functionality of the media. The validation process ensures that the material aligns with curriculum standards, is scientifically accurate, and is pedagogically effective. Simultaneously, the appearance, usability, and technical performance of the media are assessed to ensure it is visually appealing, user-friendly, and functional.

The validation instrument used in this process has been clearly outlined in the methodology section, including the criteria for evaluation and the decision-making process for determining feasibility. These criteria include aspects such as content relevance, clarity, and accuracy, as well as the media's ease of navigation, visual design, and technical reliability.

Table 1.
Indicator of Validation experts

Material Component	Media Component
The suitability of the material with the curricula	Media suitability with the learning outcomes
Completeness	Media suitability with the student characteristics
Material clarity	Media compatibility with the use of technological developments
Consistent presentation of material	Media suitability with the teaching materials
Language use	Media use efficiency (time efficiency)
Interest in delivering material	Ease of use
The suitability of the learning media with the material	The attractiveness of the colors used
Up to date	The appropriate use of the font size
Reliable	The suitability of the use of letter variations (bold, italic, and capital)
	The appropriate use of the images and illustrations in supporting meaningfulness
	Design attractiveness

After the assessment based on the indicators presented in the previous table, the average results of the validation for the material and media components are summarized in Table 2. This evaluation demonstrates the feasibility level of each validated aspect as reviewed by the experts.

Table 2.
Summary of Feasibility Test Results by Validator

Aspect	Presentage	Interpretation
Material Component	98.50%	Very Feasible
Media Component	91.60 %	Very Feasible

4. Implementation Stage

At this stage, the SIMBBIOSIS learning media, which has been deemed feasible by validators, is implemented in classroom learning activities. This learning media is applied to the topic of Viruses.

5. Evaluation Stage

At this stage, the effectiveness of the SIMBBIOSIS learning media is evaluated in classroom learning activities by comparing a control class that learns without using SIMBBIOSIS and an experimental class that uses SIMBBIOSIS for its learning activities. The measured parameters are the Pancasila Student Profile in the dimensions of critical thinking and creativity.

Critical thinking

According to the booklet "Dimensions, Elements, and Sub-elements of the Pancasila Student Profile" issued by Kemendikbudristek in 2022, the elements to be developed in phase E related to the dimension of critical thinking are that students can acquire and process information and ideas, analyze and evaluate reasoning, reflect on thinking, and the thinking process in decision-making. To measure the achievement of these elements, HOTS (Higher Order Thinking Skills) -based questions are used (Badridduja et al., 2022). The indicators of critical thinking include (Facione & Facione, 1996):

1. Interpretation: Understanding and explaining the meaning of information or events.
2. Analysis: Identifying the parts of information or arguments and examining how they relate to one another.
3. Inference: Drawing conclusions based on evidence and reasoning.
4. Evaluation: Assessing the credibility and quality of information and arguments.
5. Explanation: Justifying reasoning with evidence and presenting a clear rationale for conclusions or decisions.
6. Self-Regulation: Reflecting on one's own thinking process, making adjustments as necessary to improve reasoning and decision-making.

To measure this, an N-Gain test is conducted. The N-Gain test (normalized gain) aims to determine the effectiveness of using a certain treatment in research. The criteria for the N-Gain test are as follows

(Suryanti et al., 2021). Based on the explanation above, to measure the achievement of elements related to critical thinking, questions based on HOTS (High Order Thinking Skills) are used (Badridduja et al., 2022). To measure this, the N-Gain test is conducted. The N-Gain test (normalized gain) aims to determine the effectiveness of using a specific treatment in research. The criteria for the N-Gain test are as follows:

Table 4.
N-Gain criteria

Percentage	Criteria
0%-20%	Ineffective
21%-40%	Less effective
41%-60%	Effective enough
61%-80%	Effective
81%-100%	Very effective

Based on the testing results using the comparison of Pre-test and Post-test scores in the control and experimental classes, the results obtained are as follows in Table 6:

Table 5.
N Gain Score

Group	N Gain Score (%)	Interpretation
Experiment	82.35	Very Effective
Control	23.02	Less Effective

Based on the results above, it can be concluded that the test data is normally distributed, as the significance value is greater (>) than the alpha value of 0.05. Therefore, the statistical testing can proceed to a paired T-test. The paired T-test is a parametric test that can be used for two paired datasets. The purpose of this test is to determine whether the treatment given to the experimental group has a significant effect by examining the difference between pre-test and post-test scores within the experimental group. For a detailed view of the results, please refer to Table 7.

Table 6.
Paired t-test Results of Pretest - Post test experiment class

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Of the Difference Lower	Of the Difference Upper			
Pair 1	Pre_Test–Post_ Test	-44.64706	10.37737	1.77970	-48.26789	-41.02622	-25.087	33	0.000

Then, to assess the dimension of creativity, the key elements that students need to achieve are generating original ideas, producing original works and actions, and demonstrating flexibility in seeking alternative solutions to problems. Based on these criteria, creativity is tested by instructing students to create educational media for the community about viruses and their diseases. The assessment of creativity also follows Torrance's framework, which includes key components such as fluency (the ability to produce many ideas), originality (the ability to generate unique ideas), elaboration (the ability to add details and develop ideas), and flexibility (the ability to adapt and find alternative solutions) (Torrance, 1993). Please refer to Table 8 for the detailed results:

Table 7.
Variations of Educational Media Types about Viruses Created by Students

Experiment		Control	
Group name	Virus Education Media	Group name	Virus Education Media
Group 1	Short film	Group 1	Digital Posters
Group 2	Digital Posters	Group 2	Digital Posters
Group 3	Animation Videos	Group 3	Power point
Group 4	Digital poster +Augmented reality	Group 4	Power point
Group 5	Digital poster +Augmented reality	Group 5	Power point
Group 6	Power point	Group 6	Power point

Student Profile of Pancasila: Critical Thinking Dimension

The critical thinking dimension includes elements that students must achieve, namely the ability to acquire and process information and ideas, analyze and evaluate reasoning, and reflect on their thinking processes in decision-making. Based on this, the critical thinking dimension is tested by assessing students' abilities to solve Higher Order Thinking Skills (HOTS) level questions (Kemendikbudristek, 2024). Based on the N-Gain test results, the experimental class, which received virus learning treatment using the SIMBBIOSIS (Integrated System of Independent, Systematic, Interactive, and Fun Biology Learning) media, scored 82.35%. This can be interpreted that the SIMBBIOSIS teaching media is very effective in improving critical thinking abilities.

To determine the significance of the treatment's effect on test results, a paired t-test was conducted using SPSS. The prerequisite for the paired t-test is that the data must be normally distributed, as confirmed by the Kolmogorov-Smirnov normality test. Based on the Kolmogorov-Smirnov normality test, the significance value obtained is greater than (>) α 0.05, indicating that the data is normally distributed. After ensuring normal distribution of the data, the paired t-test was conducted. The paired t-test was chosen because it compares pre-test and post-test data within the experimental class.

According to the test results, the two-tailed significance value (Sig.) is 0.00, which means this value is less than (<) α 0.05. Therefore, it can be concluded that the hypothesis is accepted because the t-test result is less than α 0.05. This result indicates that after the treatment, the experimental class experienced significantly greater strengthening of critical thinking. This is supported by higher post-test scores. A comparison of pre-test and post-test results between the control and experimental classes is shown in the Figure 1.

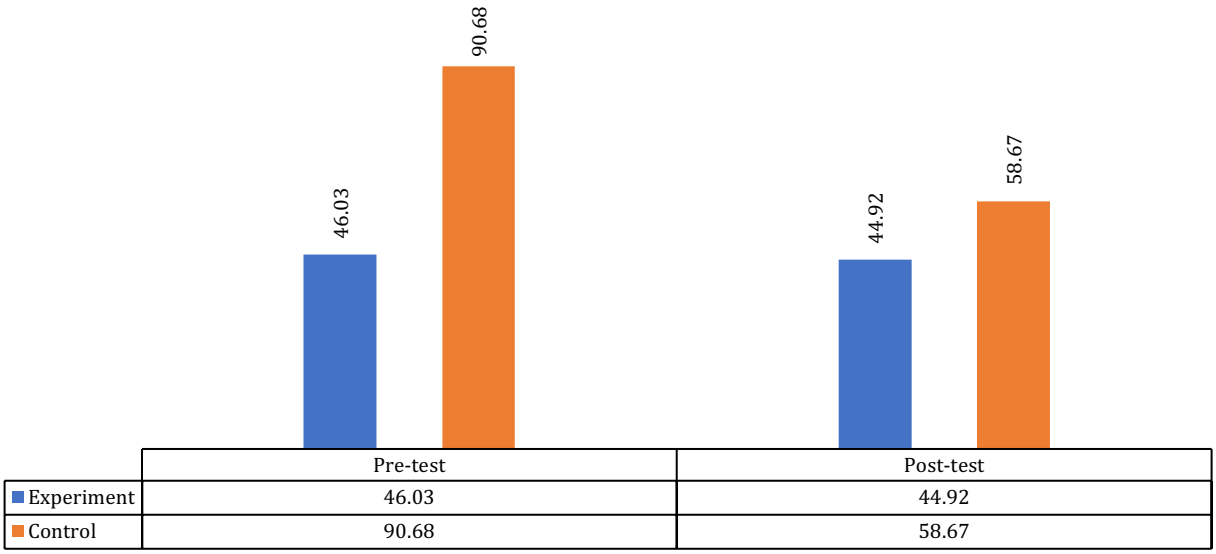

Figure 1. Comparisson Between Pre test and Post test

Based on the above chart, it can be observed that the pre-test results of the experimental group and the control group have nearly similar average scores. Therefore, it can be concluded that both classes consist of students with similar abilities initially. However, when these classes were given

different treatments, the post-test scores of both groups showed a significant difference. This demonstrates that the SIMBBIOSIS learning media has a significant influence in strengthening and enhancing critical thinking abilities. In SIMBBIOSIS, students can access knowledge systematically and in an engaging manner, which increases their interest in studying Biology, especially virus-related topics.

Student Profile of Pancasila: Creativity Dimension

Creativity is the ability to generate new ideas, original solutions, and create something different or innovative. Creativity can manifest in various fields, including arts and design, technology, sciences, business, and education. The ability to think creatively can be enhanced through practice, experimentation, and exploring new ideas (Tan & Ng, 2021). In the dimension of creativity, the key elements that students must master include generating ideas or concepts that are original, creating original works and actions, and having flexibility in thinking to find alternative solutions to problems (Kemendikbud, 2019).

Both the experimental and control classes were divided into 6 groups each. Each group was tasked with creating educational media about viruses and viral diseases that infect humans. The content of the educational media should be engaging and provide useful information such as diseases caused by viruses, symptoms, disease transmission, and prevention methods. The media created were then collected on Google Drive accessible through SIMBBIOSIS. Diagram shown in figure 2.

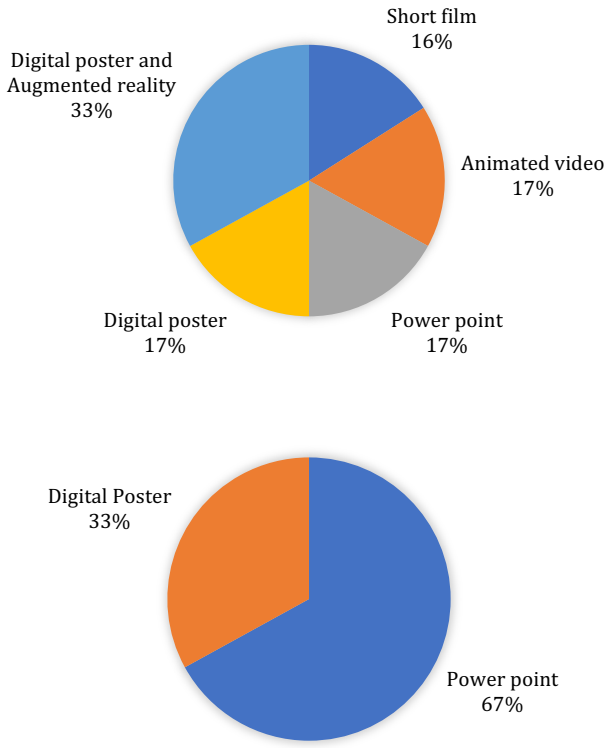

Figure 2. Distribution of various types of educational media

Based on the image above, it can be concluded that in the experimental class, there are more variations of educational media on viruses compared to the control class. In the experimental class, there are 5 variations of educational media, starting from short films, animated videos, PowerPoint presentations, digital posters, and digital posters with augmented reality. Whereas in the control class, there are fewer variations of educational media, only consisting of PowerPoint presentations and digital posters. This suggests that the creativity dimension is stronger in the experimental class compared to the control class. In the experimental class, students are exposed to many types of media found in SIMBBIOSIS such as videos, games, and 3D models, which stimulates them to create more varied educational media compared to the control class.

CONCLUSION

The development of SIMBBIOSIS (Sistem Integrasi Merdeka Belajar Biologi Sistematis, Interaktif, dan Seru), a chatbot-autoreply-based learning media, was built upon the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). This innovative learning tool has proven to be both effective and feasible in promoting critical thinking and creativity in biology education. SIMBBIOSIS is designed to help students adapt to the Society 5.0 era while enhancing the Pancasila student profile, with a particular emphasis on critical thinking and creativity. This approach aligns with the Sustainable Development Goals (SDGs) and supports the vision of achieving Indonesia Emas 2045 (Golden Indonesia 2045). The media has undergone rigorous feasibility testing, achieving material aspect scores of 98.5% and media aspect scores of 91.6%, validated by two experts. The implementation and evaluation of SIMBBIOSIS in the classroom have demonstrated its effectiveness in fostering critical thinking and creativity, particularly in the biology subject focused on virus-related material.

Based on the findings of this study, it is recommended that SIMBBIOSIS be expanded to cover additional topics within biology, with further research conducted to assess its broader impact on science education. The results highlight the validity and reliability of the ADDIE model in developing educational media, confirming its effectiveness in improving students' learning experiences. Continued development and research are encouraged to explore how SIMBBIOSIS can further enhance students' Science Process Skills and contribute to broader educational outcomes.

ACKNOWLEDGMENT

Gratitude is extended to MAN 3 Cirebon, Indonesia for providing the opportunity to conduct this research among their students. Appreciation is also directed to Universitas Kuningan for their valuable guidance and support throughout the research process.

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