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Research Artikel

THE DEVELOPMENT OF ANIMATED MEDIA BASED ON PROJECT-BASED LEARNING TO CULTIVATE PROBLEM SOLVING SKILLS IN FUNGI TOPIC

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Abstract

Problem-solving is a daily activity that stimulates critical thinking in finding solutions. Learning fungi material also requires problem-solving skills to dig deeper into the potential of fungi based on the structure, function, and life cycle of fungi associated with applications in everyday life. This study aims to develop PjBL-based animation media to foster problem-solving skills in Fungi material. The type of research used is Research and Development using the ADDIE model. The research subjects were students of class X science at SMA Kristen 1 Salatiga. The development research results show that the animation media based on Project Based Learning is valid from the material aspect by 85% and the media aspect by 88.5%. The practicality test by student response got 83.75% achievement. The product trial shows that animated media-based PjBL can increase significantly, namely Sig. < (0.000 < 0.05) means that PjBL-based animation media effectively improves students' problem-solving skills on mushroom material. Based on the research, it can state that the PjBL-based animation media is declared feasible to be used as a learning medium in the fungicide material to improve problem-solving abilities. Thus, this research has implications for the potential use of animation media integrated with scientific learning models to empower 21st-century skills, especially problem-solving.

Keywords*: animation, project-based learning, problem-solving.*

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INTRODUCTION

Currently, information and communication technology (ICT) is experiencing an increasingly rapid development so that it can be accessed by all groups in obtaining information using technology products in the form of smartphones, computers, and laptops. Technology advancements help humans make work easier in aspects of life, namely culture, health, economy, and education (Sadikin *et al*., 2020). Besides, academic units can elaborate technological advances in facilitating students to receive and understand the material. This condition follows the statement of Subekti *et al*. (2018)), that technology affects the school's learning system by ensuring students have learning skills, use technology, use information media, be creative, and innovate.

Mukminin *et al* (2019) state that various problems were still found in schools related to the use of learning media, namely dominant utilization of media by teachers, using student worksheets, student books, and one-way power points (teacher center). The application of instructional media is intended to create interest and interaction between teachers and students during the learning process. Prasojo (2018) stated that in the learning process, teachers should be able to take advantage of interactive media to build student activity in improving cognitive, affective, and psychomotor abilities. Wilsa (2019) also stated that interactive media could be affected students' thinking power to improve student cognitive learning outcomes. The use of interactive media in classroom learning today is a necessity that cannot ignore because it can make it easier for students to accept and understand the concept of the material. Puji (2015) also argued that interactive media made learning material easier because it displayed real objects, stimulated the senses to interact, and could be provided a visualization with motion pictures (animation) and audio.

Interactive media in the form of animation can be designed using Adobe Animate software by presenting a more innovative and fun concept. Darmawan (2020) stated that Adobe Animate was software that supported the design of animation media for learning in the form of games or films with a more dynamic image display. Ferry *et al* (2019) explained that animation media could be reinforced concept understanding because it involved an audiovisual process. Sadikin & Hakim (2019) emphasized that animation media provided students with the opportunity to concentrate on visual images to understand the material's concept according to the learning objectives. The process of understanding concepts requires students' reasoning power to capture complete information (Herlina, 2017). Based on these studies, the Adobe Animate program is interesting to use as an interactive learning media, especially in Biology subjects. Selection of the appropriate learning media can help students' conceptual understanding in improving students' cognitive, affective, and psychomotor abilities and fostering interest in learning.

The exertion of animation media is expected to strengthen understanding of the concept that is packaged with the Project-Based Learning (PjBL) model. Project-Based Learning (PjBL) is a learning model that provides opportunities for students to learn independently to explore and solve problems (Permana & Setyawan, 2019). Tamim & Grant (2013) explain that PjBL frees students to explore information, engage students in research and assessments, understand concepts, and find solutions to solve problems. Project-based learning establishes all students as active learners and is challenged to produce products as a learning outcome. These PjBL activities are related to the decision-making process to problem-solving (Sumarni, *et al*., 2016). The PjBL learning model's advantages can improve abilities, namely cognitive, affective, psychomotor, and student learning motivation (Hakim, 2015). Winaya *et al* (2017) also argued that the advantages of using the PjBL could raise motivation and collaboration. Also, it can improve research skills and improve problem-solving abilities. This information is in line with Fajarwati *et al* (2017), who stated that interactive multimedia in project-based learning increased motivation and problem-solving skills. During project-based learning, students work collaboratively to foster interest in learning, problem-solving skills, and critical thinking.

Research conducted by Sugandi & Rasyid (2019) stated that the learning processed using

multimedia based on PjBL could improve students' cognitive abilities and creativity. Students' creativity played a role in innovative thinking processes in the problem-solving process. Based on previous research, this research uses animation media-based PjBL, which contains several animations to strengthen the concept of mushroom material. The animation design allows an interface that allows students to become independent learners and able to work together through project activities. Furthermore, the flow of the PjBL model in animated media becomes a guide for teachers to teach students through project activities in the form of activities using the *Rhizopus sp* in the form of tempeh products but derived from different substrates. From these activities, students can analyze the impact of different substrates on the activity of *Rhizopus sp* and the resulting tempeh products.

Problem-solving is our daily activity in solving problems because it stimulates critical thinking in finding effective problem-solving solutions in everyday life. Problem-solving is a skill, not just knowledge, problem solving invites students to dig deeper to solve problems with their abilities and creativity (Samani *et al*., 2016). Problem-solving is a cognitive ability that focuses on solving problems in everyday life based on hypotheses, relevant data, and finding the right solution (Yosefina *et al*., 2014). Fajarwati *et al* (2017), explained that the problem-solving process aims so that students can recognize problems, use experience in making new concepts about problems and use effective strategies to solve problems. The process for students to be involved in a subject project will train students' problem-solving skills.

Implementing PjBL can stimulate students' courage in the decision-making process in solving problems with various alternative answers. Based on research, Sumarni *et al*. (2016) found that the PjBL learning model was able to foster problem-solving abilities through problem investigation activities to problem-solving. Furthermore, the PjBL model supports students' higher-order thinking processes, namely creative, innovative, and critical thinking (Trimawati, 2020). Based on these opinions, the characteristics of the PjBL model are appropriate in supporting students' problem-solving abilities if implemented through animation media.

Based on the interview with the biology teacher at Christian Senior High School 1 Salatiga, the main problem in learning biology was the assumption of students that biology was boring because they memorized a lot, wrote Latin names, and understood scientific concepts. Besides, students were not accustomed to thinking critically in finding solutions and solving problems, so students tend to be passive in expressing opinions. Raida's (2018) explains that the factor that causes students to find it challenging to learn biology is that biology has characteristics in each material consisting of concepts, complex problems, abstracts, and Latin names. Other difficulties in learning biology are caused by learning strategies that use Teacher centred learning. In overcoming student learning difficulties, teachers can create innovative learning and educate students to use interactive media so that students can more easily understand biology concepts.

One of the biology materials that require interactive media in the learning process is fungi material because learning the main material of fungi requires observation through the practicum. The basis for the classification of fungi must be visualized so that students can understand the characteristics of fungi, their groupings, and the benefits of fungi for life. Fungal material is part of microbiology and has a low interest (Lubis & Hasarin, 2017). This is following Darmawan's (2020) opinion, the selection of learning methods and media that are by the characteristics of students in biology learning must pass the level of understanding before reaching the scientific method. It is hoped that the essence of interactive media on function material can overcome the problem of understanding the concept of material and its application in everyday life.

Animated media presents sub-main material for fungi, including the stages of each division's life cycle, differences in morphological characteristics, classification, and their role in everyday life. Through project-based learning, students can develop conceptual understanding and mastery of functional material based on creativity in utilizing technology and producing innovative products.

This information is in line with Wahyuningsih's research (2020) that the development of animation media is urgent because it can overcome learning problems. Including low learning outcomes, ineffective learning strategies, and a lack of learning resources to increase interest, learning outcomes, skills, and problem-solving. Based on the description above, research was conducted on "Development of Animated Media Based on Project Based Learning to Foster Problem Solving Ability in Class X Functional Materials" to answer the challenges of learning problems.

This study aims to develop animation media to foster students' problem-solving abilities, test the feasibility of animated media products based on Project Based Learning to foster students 'problem-solving abilities, and test the effectiveness of animation media based on Project Based Learning to foster students' problem-solving skills.

METHOD

This method uses research and development (Research and Development), which model used is the ADDIE model (analysis, design, development, implementation, evaluation), which presents detailed and systematic concepts and procedures. ADDIE development model procedure by (Branch, 2009) Branch is listed in Figure 1 below.

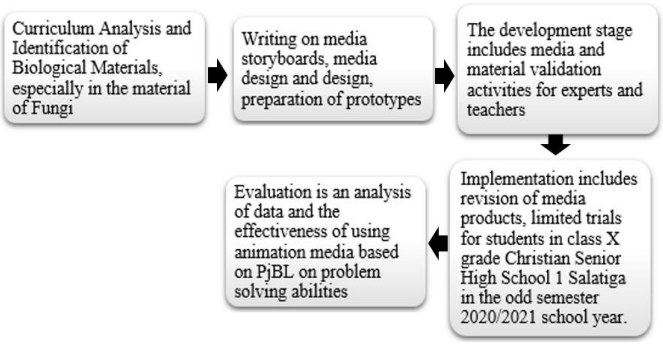

Figure 1. Product development flow based on the ADDIE model

Based on Figure 1, the implementation of the ADDIE model stage is as follows: 1) analysis stage: conducted interviews with subject teachers to obtain data, namely curriculum analysis, and biology topics, 20 design stage; 2) making prototypes and initial design of animation media made from Adobe Animate, 3) development stage: the product developed is an animated media that will process through validation tests by subject matter experts and media experts, 4) implementation phase: discussion process with subject teachers related to animation media that will be implemented in learning and to determine students' readability levels, 5) evaluation stage: conduct a feasibility analysis of a product. The data that has been obtained in the form of quantitative and qualitative will be analyzed using Microsoft Excel and SPSS software.

The data were analyzed using Microsoft Excel software from the development stage with a response questionnaire instrument through calculating the validity or feasibility criteria and the practicality of the media. Meanwhile, the use of SPSS software assistance is carried out at the evaluation stage to test the effectiveness of using animation to improve problem-solving abilities.

Table 1. Media validation indicators from subject matter expert and media expert

Aspects	Indicator
Subject matter expert	
Quality of content and purpose	The context of the material is directed at real situations that can stimulate higher-order thinking processes, Accuracy of material with learning objectives, conformity with basic competencies, completeness of the material, depth of material, the balance of material with examples of problems that can solve, attracting attention and building creativity, according to abilities.
Quality of learning	Provide learning assistance in understanding concepts, flexible learning, creative thinking, test quality, and assessment.
Media expert	
Quality and display design	Interest in media display, suitability of image illustrations, sound quality, suitability of media with learning objectives, suitability of media with student characteristics, the ability of media to attract student's attention, the ability of media to create student enjoyment, lead students to produce a project, ability of media to help to understand and remember information.
Programming	Ease of media in learning and learning practices, attracting student interest, clarity of instructions, quality of media

Table 2. Assessment Indicators for Media Validation by Teachers

Aspects	Indicator
Content	1) The suitability of the material with competency standards, learning objectives, learning indicators 2) The suitability of images with material, examples with material, questions with material, student abilities
Media	1) Ease of operating the media

	2) Clarity of instructions for use and attractiveness of the media 3) The ability of the media helps students understand information and triggers student creativity 4) The ability of the media to activate students in building their knowledge

The categorization of the level of product feasibility is based on categories, namely: 1) very valid, does not need to be revised (84%-100%), 2) valid, does not need to be revised (71%-83%), 3) quite valid, needs a little revision (61%-70%), 4) less valid (41%-60%), 5) invalid, need a total revision (Azwar, 2012). The practicality criteria of development products are based on their respective categories, namely: 1) impractical (0% – 20%), less practical (21% – 40%), quite practical (41% – 60%), practical (61% – 80%), very practical (81% – 100%) (Setiawati et al., 2013). The practicality of animated media-based PjBL is carried out through the implementation phase, namely, when the learning media is implemented. At the implementation stage, students were asked to fill out a questionnaire regarding the use of animation media. This practicality was obtained through a student response questionnaire after it was implemented and followed by learning that applied animated media-based PjBL.

This research was conducted in the odd semester of the 2020/2021 Academic Year at SMA Kristen 1 Salatiga. The population in this study were students of class X Christian Senior High School 1 Salatiga who had never been given an explanation of the fungi topic in the Biology subject. The samples taken were 74 students who came from three different classes with heterogeneous conditions. Below is Table 3, which contains indicators for measuring problem-solving skills.

Table 3. Indicator Measuring of Problem Solving Skills

Aspects	Indicator
Formulate a problem	1) defining the problem, 2) making observations 3) understanding the problem 4) analyzing the cause of the problem
Describe the problem	1) describing the problem 2) identifying the problem 3) understanding the concept 4) describing the problem
Provide solutions	1) planning a solution, 2) reviewing literature studies 3) analyzing the answer to the solution 4) assessing alternative solutions

The criteria for the assessment of problem solving skills consist of the following intervals: very weak (0-20), weak (21-40), moderate (41-60), strong (61-80), very strong (81-100) (Hanief & Himawanto, 2017).

After revising the animation media-based PjBL product at the development stage and obtaining the feasibility of the product, then the product is implemented in the same class, class X IPA Christian Senior High School Salatiga. At this stage, measurements are made on improving students' problem-solving skills using media products.

The data collection technique in this study used a questionnaire technique by validators of subject matter experts and media experts to validate PjBL-based animation media and respond to the feasibility level of PjBL-based animation media. The research design used is one group pretest & post-test design. The research design is as follows. Table 4 below is a product trial display that uses a one-group pretest and posttest design.

Table 4. Design of One Group Pretest & Post test (Sugiyono, 2008).

Group	Pre-test	Treatment	Post-test
Experiment	O_1	X	O_2

Information:
X = Learning biology using animation media
O_1 = pre-test
O_2 = post-test

The effectiveness of animation media was analyzed using the one-sample t-test. Provisions for acceptance of the alternative hypothesis (Ha) if the p-value. If the resulting sig is greater than 5% degrees of freedom (.sig> 0.05), then H0 is accepted. The data analysis technique uses instrument analysis of items, including validity, reliability, differentiation, and difficulty level. The questions' validity is measured using Microsoft Excel with the Product moment correlation. The reliability of the items through Cronbach's alpha calculation was 0.74, with the category reliable and suitable for use in the implementation of the research.

Normality and homogeneity tests are prerequisite tests before testing the hypothesis. The normality test is used to determine the distribution of normally distributed data using the Shapiro Wilk

test criteria with the hypothesis of p-sig. > 0.05, the population data is normally distributed. Homogeneity test using the Levene test criteria with the provisions of p-sig. > 0.05, the data is homogeneous, which means that the data has equal ability (Sugiyono, 2009). Animation media-based PjBL in improving problem-solving skills if the value of tSig < with a significance of 0.05, and this information means that there is a difference in the average value of students' problem-solving skills on the acquisition of the pre-test compared to the post-test. So it can conclude that animation media-based PjBL on the fungi topic effectively improves students' problem-solving skills.

RESULT AND DISCUSSION

Analysis Stage

The first step in the ADDIE model stage is analysis. Stage analysis is the basis for achieving other steps, which are carried out by analyzing the objectives by determining the topics to be taught, learning objectives, subjects to be delivered, student characteristics, the use of media in teaching, and following the targets.

So in the analysis phase, the researcher conducted a needs analysis and found that students' problem-solving skills needed to be improved because this ability was still rarely measured in class. Because it is seldom estimated, problem-solving skills are rarely trained and empowered. Furthermore, the direction of developing animation media-based PjB is carried out as a solution because it becomes a learning tool that will equip students to understand concepts to solve problems through project activities.

The biology topics analysis phase was carried out through interviews with biology teachers at SMA Kristen 1 Salatiga; The main problem is that the learning media used are one-way, namely student worksheets, student books, and power points. The learning media is less effective and efficient because it has not significantly increased students' understanding of biology. Based on the material analysis, it is concluded that teachers and students need learning media. The learning process with the visualization function can improve students' understanding. The animation media of the material function aims to foster students' problem-solving abilities. The content of the material used is fungi because schools still do not have digital media that supports learning fungi topic. In addition, learning products from fungi topic have never been produced, so it is hoped that in learning using animation media-based PjBL, students can follow up their understanding through the media into a learning product through project activities.

Design Stage

The animation media design process begins with making an idea about the design and appearance of the features that will be provided on the product. The placement of features and structures is based on an analysis of needs and characteristics so that the product will be directed at achieving learning objectives. The contents of the media as content that will support problem-solving skills are arranged in the form of a learning material framework so that it will also be adapted to the learning flow, namely PjBL. The results of ideas, student characteristics, and content of lesson materials will become a storyboard. The storyboard will be the basis for the description of the animation media that will be compiled using Adobe Animate.

Initially, the media consisted of a front view, namely basic competencies, indicators, and learning objectives. The media contains the PjBL flow starting from the presentation of fungal structures, groupings, life cycles, and examples of the types of fungi. Furthermore, a question feature will direct students to the project plan. Students directly input project planning activities on the media accompanied by a period of processing time. Some additional information about mushrooms is also provided in the media to help students to get important information in doing the project.

Development Stage

The animation media display based on the PjBL model is designed with four main menus: introduction, Project Based Learning, evaluation, and profiles. The animated media display based on the PjBL model is designed with four main menus: instructions for using media, introduction, Project Based Learning, evaluation, and profiles. Figure 2 (a) is an initial menu of fungi topic, presented with material characteristics of mushrooms, equipped with supporting pictures. In Figure 2 (b), the PjBL

steps are illustrated by providing project topics to students so that each student can first understand the project's topic.

PjBL steps are as follows: learning activities are preceded by the provision of material using animated media. From the material provision, the teacher makes a question which will be carried out as a project assignment. This stage is the beginning of project activities, and students are asked to analyze the context of the phenomenon from the question. In this case, the question relates to how students predict the activity of Rhizopus sp, which is influenced by several substrates. Later, students will form groups and plan project activities to make tempeh, but each group must use different materials. In the next stage, students in groups were asked to arrange a project planning schedule. Preparing a plan to complete activities according to the target is crucial.

During the implementation of activities, the teacher continues to assist in the development of the project being carried out. When the project is completed, students are expected to be able to evaluate the project being worked on and try to answer the initial questions given by the teacher. The student's findings in the process and product of the project will then communicate to each group in class.

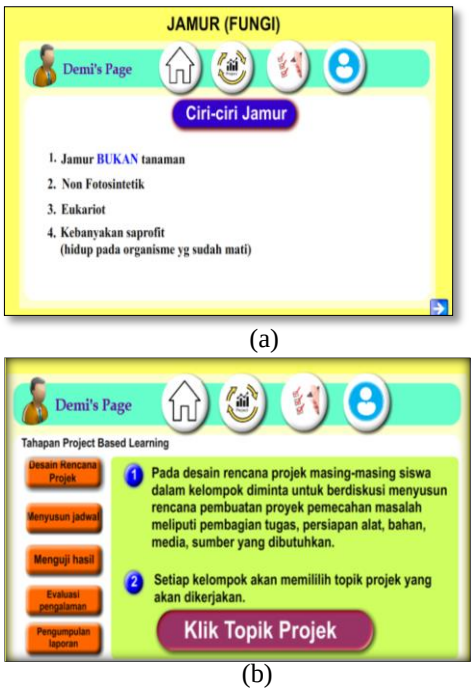

Figure 2. (a) Introduction View (b) Project Based Learning Activity View

Animation Media Validation

The media validation stage for subject matter and media experts is carried out in the third stage (development) on the ADDIE model. The content validity used through the construction of the assessment instrument is based on two main aspects, namely the validation of subject matter experts. The following is a summary of the results of the validation of the PjBL model-based animation media, which is presented in the Table 5.

Table 5. Summary of Subject Matter Expert Validation

Validation aspects	Percentage	Criteria
Quality of content and purpose	75 %	Valid
Quality of learning	95 %	Very Valid
Average	85 %	Very Valid

Based on Table 5, the average value of the validity of animated media based on the PjBL model is 85% with the very valid category.

Based on feedback from experts, they provide suggestions, namely that the material is still oriented to concepts but has not been directed to the pertinent aspects of everyday life. The input given by media experts is the consistency of the use of type and font size and the proportional size of the image so that it can be seen easily and attractively. In the initial interface on the media, it is also necessary to provide introductory features and instructions for users to use the media.

Validation of media experts was also carried out based on content validity (Table 5). The instrument was designed to focus on two main aspects, namely the display design and programming, which were assessed by media experts to determine the feasibility of the media obtained with an average percentage based on the assessment criteria. The following is a summary of the results of the animation media-based PjBL validation:

Table 6. Summary of Media Expert Validation

Validation aspects	Percentage	Criteria
Quality and display design	90 %	Valid
Programming	87 %	Valid
Average	88.5 %	Valid

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Two Biology teachers carried out the validation test of the PjBL model animation media (Table 6). Each teacher responded to the feasibility of animation media based on the PjBL model: one teacher for the media aspect and one for the material element. The following is a summary of the results of the animated media-based PjBL practice test:

Table 7. Summary of Biology Teachers' Responses to the Use of PjBL animated animated media

Aspects	Percentage	Criteria
Content	82.5 %	Valid
Media Display	85 %	Valid
Average	83.75 %	Valid

Suggestions for improvement from each validator have been completed at the validation stage as input for improving animation media. Recommendations from each validator and teacher responses are presented as follows:

Tabel 8. Summary of suggestions for improvement from experts and teacher

Validator for validation stage	Indicator	Suggestions for improvement
Subject matter expert	Material balance with examples	Added the role of fungi in everyday life.
Media expert	Media display	1. The media need to display a proportional layout between the image and the size of the text (font). 2. The Media need to add a feature on how to use media as an introduction
Biology teacher	Material balance with examples	The material conveyed through learning media was already interesting; only its application in everyday life can be added so that students were more interested in learning about functional material.

Following input from media and content experts, researchers discuss and collect materials to improve and improve animation media. This continuous process requires mutual reflection according to reviewer feedback based on subject matter experts and their points of view. he validation test results show each reviewer's opinions and feedback regarding the media's appearance and the material's balance with examples. The material expert's advice focuses on the relevance of the concept to the application of everyday life, and the media expert provides suggestions for proportional improvement in the presentation of images and texts in the media.

Practicallity of Animation Media

The data from the animated media-based PjBL practicality test were obtained from student responses. So the practicality test that was carried out was only limited to student responses in the use of media. The following is a summary of the results of the practicality test from student responses in Table 10.

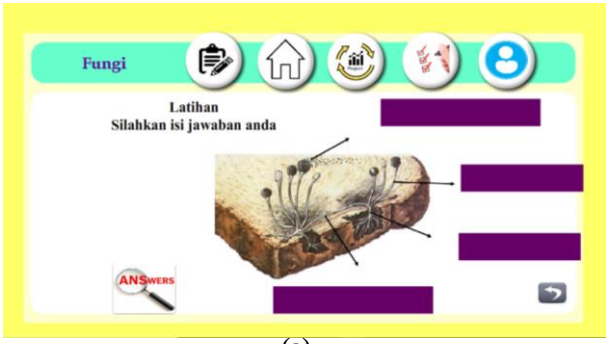
Table 10. Summary of the Results of Students' Responses to the Practicality of Animation Media

Aspect	Percentage	Criteria
Learnability	76.9 %	Practical
Efficiency	74.3 %	Practical
Memorability	73.2 %	Practical
Satisfaction	74.8 %	Practical
Average	74.8 %	Practical

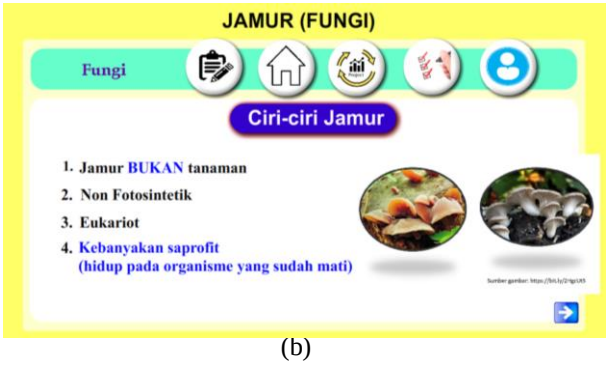
From Table 10, the average value of response to the use of animation media is 74.8% (practical). Measurement of student responses was carried out at the implementation stage of the ADDIE model. When the animation media test, students were asked to fill out a response questionnaire related to the use of learning media.

Implementation Stage

The initial stage of implementation was preceded by improvement of learning media based on suggestions for improvement from material and media expert validators as well as from biology teachers. In addition, the user manual feature also needs to be added. This condition is part of the application modified according to student needs. This information is known as a one-on-one evaluation. One-to-one evaluation is carried out in the development stage. These are all important to ensure the material is prepared to follow student preferences. The following is an improved display of the animated media feature in Figure 2.



(a)

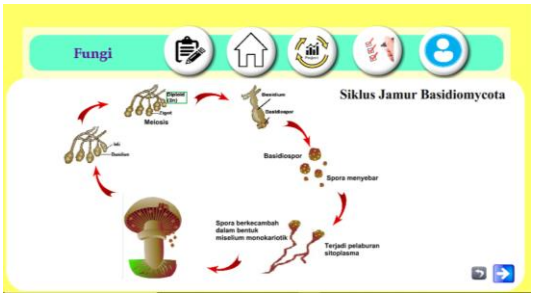


(b)

Figure 2. (a) improvements to the addition of media recognition features; (b) improvements in the form of adding a quiz menu to students

Figure 2 is an improvement in learning media based on suggestions from validator respondents. Improvements include adding a feature component, adjusting the font size, and adding a quick quiz based on fungi images. This improvement is made to optimize the animation media by considering the student learning process to reinforce the concept. Figure 3 below is a display of the validation results.

(a)



(b)

Figure 3. (a) animation on the life cycle of fungi; (b) student evaluation activities to answer questions

Figure 3 (a) shows the life cycle animation of Basidiomycota fungi one by one. This animation works to display in detail the sequence of the Basidiomycota life cycle so that students can observe it in detail. Furthermore, Figure 3 (b) shows learning evaluation services on learning media. Students are expected to practice competence and understanding of functional material through the questions provided in the learning media. PjBL learning model provides opportunities for students to demonstrate knowledge or skills based on the planned project steps. This activity turned out to have a positive impact so that students could be more active in the learning process. Students actively find out everything needed in project activities, and even the context of problem-solving is done by linking the information obtained in class with the findings made while working on the project.

Limited trials were carried out online using the help of the Zoom Meeting platform. The learning implementation was carried out in 8 hours of meeting (1 meeting: 30 minutes). Seventy-four students from three different classes attended the learning activity. The trial was carried out to determine the level of readability of animated media based on the PjBL model and the effectiveness of the use of the media on students' problem-solving abilities. The test of the effectiveness of using animation media for problem-solving is carried out through prerequisite tests, hypothesis testing and student problem-solving achievement. A summary of the prerequisite tests is presented in Table 9 below:

Table 9. Prerequisite test

Prerequisite tests	Shapiro -Wilk	Degree of statistical confidence	Conclusion
Normality	0,070	0,05	Normal

Based on Table 9, a prerequisite test was carried out using the normality test on the Shapiro Wilk criteria. The proposed hypothesis is if p-sig. > 0.05, then the population data is usually distributed if p-Sig. <0.05, then the population data is not normally distributed. The result of the prescription test is 0.007, indicating that the information is normally distributed. The result is that the students' problem-solving ability has a significance value

greater than (Sig. >). This information means that the data is normally distributed. Table 10 is a summary of hypothesis testing regarding the test of the effect of animation media on problem-solving.

Table 10. Hypothesis Testing Problem Solving Skills

Type of test	*One Sample t-test*		α	Conclusion
	Variable	Sig.		
Hypothesis testing	Problem-solving	0.000	0.05	Ho was rejected

The hypotheses in this study are: 1) H0: Animated media based on Project Based Learning is not effective against problem-solving abilities, and 2) Ha: Animated media based on Project Based Learning is effective in fostering student problem-solving abilities. Based on Table 9, the hypothesis test results in 0.000 so that H0 is rejected. This means that Project-Based Learning-based animation media is effective in fostering student problem-solving abilities.

Evaluation Stage

The response to the use of media consists of four aspects of achieving practical results. These results indicate that students are generally satisfied with using PjBL based on animation media because the media has provided features that users can easily reach. The following is a summary of the results of problem-solving skills in Table 11.

Table 11. Result of Problem Solving Ability

Indicator	Percentage	Criteria
Formulating Problems	75 %	Strong
Deciphering the Problem	65 %	Strong
Provide solutions	75 %	Strong
Implementing Solutions	75 %	Strong
Evaluation	77.5 %	Strong
Average	74 %	Strong

Based on Table 11, the achievement of problem-solving abilities almost the same results for each indicator. The indicator describing the problem gets the lowest score, namely 65%. Even so, the indicators describing the problem are still in the strong category.

Overall, the student's problem-solving ability got an average of 74% in the strong category. This shows that students' problem-solving abilities can be trained in the implementation of animation media-based PjBL. This opinion is in line with the research of Isnaini *et al.* (2018) that the use of attractive learning media and supported by a meaningful learning model or method can affect students' problem-solving abilities from external factors.

The researchers found that the deciphering the problem aspect was still low in problem-solving skills. This is because students were still constrained in understanding the context of the problem at hand, so they had difficulty describing the issue more comprehensively. One example of a problem that is difficult to describe is when students were asked a question about a problem about how the fungus Rhizopus sp can ferment and what impact it has on different substrates. Students are still focused on one concept of how the life cycle of *Rhizopus sp* but has not been able to determine the concept more broadly in an applicative manner. Of course, this is due to animated media's presentation, which is still validated in an unstructured problem presentation format that requires a particular intellectual strategy. Yu et al. (2010) explained that the internalization of knowledge in digital platforms needs to be packaged in a structured manner to facilitate students' problem-solving skills. In addition, Scott (2017) said that in solving problems, students must also be familiar with a question in the problem category. Next, students will find an idea for the novelty needed to solve the problem.

Project-based learning emphasizes the learning process through authentic problems. In practice, senior high school students can already apply their knowledge based on authentic situations. The proof is that students can find the information they need through animated media-based PjBL to solve problems. In addition, project-based learning allows students to carry out the problem-solving process in stages. Rezeki *et al.* (2015) also argue that the project-based learning model is very influential in fostering problem-solving abilities because it focuses on directing concept understanding, training skills, and being able to solve problems through Project-Based Learning steps. The Project-Based Learning learning model emphasizes the learning experience of students so they can think creatively, work in

groups, and produce products based on their creativity (Na'imah *et al.*, 2015). Project activities can support students in solving problems and producing products.

Using animated media-based PjBL is also very helpful for students to practice their ability to analyze and investigate the theoretical concepts of fungi topic. For example, how the structure of fungi and the reproductive cycle can relate to the primary grouping of fungi. Concretely the characteristics of mushrooms can be presented through animation media, and how the spread of mushrooms can also be animated to provide theoretical reinforcement. Herdianti & Ningsih (2019) reveals that learning using animated media based on Adobe Animate can improve students' understanding of fungi topic because material delivery is more precise and meaningful through images and animation. So that students focus more on studying the material and interpreting essential abstract material. Animated media based on PjBL guides students to learn actively by identifying the structure and function of fungi groups. Besides, students can test their understanding independently through competency tests through animation and answer evaluation questions. In line with Rusman (2012) opinion, media helps understand and remember the material being studied and stimulates students' interest in learning.

Due to the conditions of the Covid-19 pandemic, learning carried out online is challenging to implement learning. Therefore, animated media based on PjBL facilitates students accessing android or computer applications. This condition encourages students to study independently to repeat the studied material. In Herdianti & Ningsih (2019), students who learn to use animation media individually can remember and receive information in a directed manner so that learning activities are more meaningful.

The project results in learning are a video of the project implementation and a written report. The application of material concepts through projects trains students to understand the concept as a whole based on the contextual application so that students can investigate the subject matter to the problem-solving process. When students construct their knowledge, they are expected to be able to design and produce tangible products. This opinion is in line with the research of Dewi *et al* (2017) that when students are directly involved in the experiment, students can interpret their knowledge plus from literature studies so that they can produce meaningful products.

Project tasks implement in groups by conducting experiments with *Rhizopus sp*. on various substrates. The trial substrate comes from various grains which can ferment to make tempeh. This project assignment provides learning meaning for students to solve problems related to the fermentation rate of Rhizopus sp. on multiple substrates and link them to the reproductive cycle of these fungi. Issues arising from making tempeh will analyze based on facts and observational data. Students will try to relate the concept of the studied material and the problem solved in the project. Students' problem-solving abilities will be visible through the way students describe problems and provide solutions.

In practice, students generally understand the context of the problem but experience problems describing solutions for problem-solving. The findings in this study are that some of the presented group reports have led to the observed problems but have not described the form of the concrete issues observed, so they have an impact on how to provide solutions. This factor is because students are not used to writing reports systematically, so they are not maximal in pouring ideas/findings into reports (Umaroh, 2020).

CONCLUSION

Based on the research results, animation media-based PjBL can foster problem-solving abilities in good categories. Positive results show this problem-solving ability at the stage of development and testing of media implementation. The development of animation media based on the PjBL model was declared feasible based on the validation of material experts valid, validation of media experts valid, and biology teachers valid. Animated media based on the PjBL model effectively cultivates problem-solving abilities based on hypothesis testing using the one-sample t-test. It can conclude that the animated media

material fungi can foster students' problem-solving skills.

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