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The differences of students' critical thinking and science process skills using discovery learning model integrated with video animation media

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Abstract

Critical thinking as one of the competencies in education in the 21st century requires students to be curious about information to gain a deep understanding. Problem-solving in addition to training critical thinking also trains science process skills. This study aims to analyze whether or not there are differences in students' critical thinking using discovery learning models combined with animated videos and analyze whether or not there are differences in students' science process skills using discovery learning models combined with animated videos. This study used a quasi-experimental method with a nonequivalent post-test control group design. The population of this study is students of class XI MIPA SMA N 1 Surakarta. The sampling technique used is purposive sampling, with XI MIPA 5 as the experimental class and XI MIPA 3 as the control class. Data were collected through documentation, observation, and written tests on critical thinking and science process skills. Hypothesis testing using a T-test to investigate the difference between critical thinking and science process skills of students who are taught using the discovery learning model combined with animated video media and classes that only use the discovery learning model. The results showed differences in students' critical thinking using the discovery learning combined with animated video, and there were differences in students' science process skills using the discovery learning combined with animated video.

Keywords: Critical thinking; Science process skills; Discovery learning; Animated video

1 Introduction

Critical thinking as one of the competencies in education in the 21st century requires students to be curious about information to gain a deep understanding. Critical thinking is the ability of students to solve problems so that they can be trusted and make sense. Students can get conclusions in solving a problem by thinking critically. Critical thinking is a process aiming to prove, explain, and solve a problem collaboratively [1]. Problem-solving in addition to training critical thinking also trains science process skills. Science process skills are students' skills in developing, understanding, and discovering knowledge to apply the scientific method [2].

The results of observations and interviews of teachers and students in class XI MIPA SMA N 1 Surakarta in face-to-face learning and distance learning are that not all students are actively involved in learning and few students try to analyze and criticize the material presented. Students are less involved in asking questions or expressing opinions, that is only 2-5 students in each class. Asking question is one of the thinking processes that can stimulate students to think critically, think creatively, and solve problems [3]. Learning in class is only limited to the interaction of teachers and students, and the lack of interaction between students in group discussion activities and presentations to express ideas and opinions. Communicating is one aspect of science process skills that are still underdeveloped in the classroom. The learning model

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used emphasizes the verbal delivery of material from the teacher to students [direct instruction]. The teacher at the time of learning presents the material with the lecture method and does the assignment. The lecture method makes students listeners for information from the teacher, so that students' learning is only limited to memorizing concepts. The lecture method does not empower thinking ability and science process skills [4].

Students' critical thinking can be used to deal with various problems that exist in life. Teachers can guide students to develop critical thinking by providing learning activities that are appropriate to the subject and come from the creativity of the teacher [5]. Critical thinking can be developed by applying appropriate learning models [6]. Teachers can use learning models that can make students active and independently analyze the problems. Aspects of critical thinking can be seen with the application of the discovery learning model. Science process skills that are not trained by teachers require learning models and teaching materials that aim to develop students' science process skills [7]. A learning model that provides activities for students to be able to develop science process skills is discovery learning.

Discovery learning guides students to be able to investigate and discover science concepts independently so that the knowledge and skills acquired by students are based on students' findings, not just the results of remembering existing facts [8]. There are recommendations to be able to combine discovery learning with learning technology so that content and pedagogy can be delivered properly [9]. One of the learning media is in the form of video. The discovery learning model assisted by video media trains students to find their concepts so that students can participate actively and directly in learning. Students in learning can also explore more knowledge that can be applied in the problem-solving process [10].

Based on the background of the problem, and the formulation of the research problem is there a difference in students' critical thinking using the discovery learning model combined with animated videos? And is there a difference in students' science process skills with the use of discovery learning models combined with animated videos? Based on the formulation of the problem, the purpose of this study is to analyze whether or not there are differences in students' critical thinking using the discovery learning model combined with animated videos and to analyze whether or not there are differences in students' science process skills using the discovery learning model combined with animated videos.

2 Methods

This study used a quasi-experimental method with a nonequivalent post-test control group design. The population used is class XI MIPA SMA N 1 Surakarta. The sampling technique was purposive sampling, with XI MIPA 5 as the experimental class and XI MIPA 3 as the control class. The experimental class was given the application of the discovery learning model combined with animated video media, while the control class only used the discovery learning model. Data were collected through documentation, observation, and written tests on critical thinking and science process skills. The research instrument consisted of critical thinking test questions, science process skills test questions, and discovery learning syntax observation sheets. The instrument validation technique used validity and reliability tests. The prerequisite test used normality and homogeneity tests, while the hypothesis test used the T-test to determine the differences in students' critical thinking and science process skills using the discovery learning model combined with animated video media and classes that only used the discovery learning model.

3 Results

Research that has been carried out at SMA Negeri 1 Surakarta in the even semester of the 2021/2022 academic year, the results obtained are scores of students' critical thinking and science process skills on immune system material.

1.1 Critical Thinking

The critical thinking of students in the experimental class using discovery learning combined with animated videos [80.83] was higher than the control class that only used discovery learning [73.89]. The average value of critical thinking in the experimental class and the control class is in the high category. Aspects of critical thinking skills from interpretation, analysis, evaluation, inference, explanation, and self-regulation. The value of each aspect of the experimental and control class's critical thinking skills is shown in Figure 1.

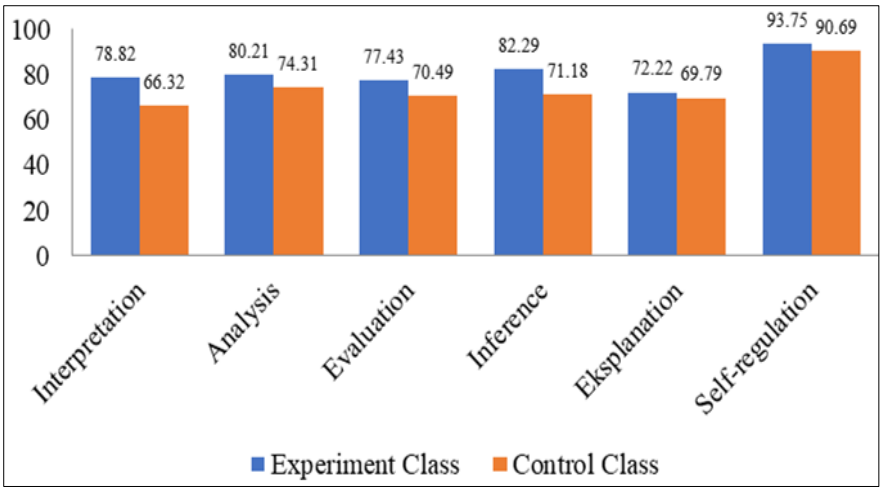

Figure 1 Average Score of Critical Thinking

1.2 Science Process Skills

The science process skills of students in the experimental class using discovery learning combined with animated videos [70.39] were higher than the control class that only used discovery learning [63.14]. The average value of the science process skills of the experimental class is in the high category and the average value of the control class is in the medium category. The value of the experimental and control class science process skills in the aspects of observe, conclude, measure, classify, predict, and communicate is shown in Figure 2.

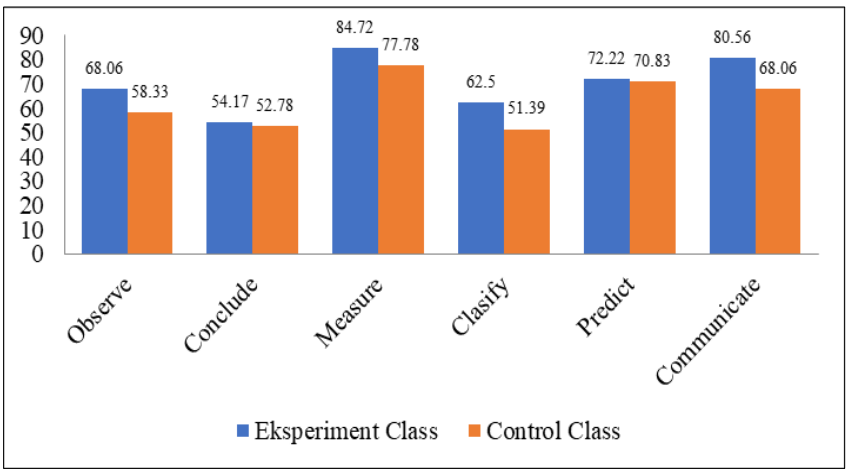

Figure 2 Average Score of Science Process Skills

3.1 T-test

The results of the T-test calculations on critical thinking and science process skills data contained in Table 1 show Sig [2-tailed] of 0.033 and 0.048. The results of this significance indicate that decision-making H_0 is rejected and H_1 is accepted. The decision can be made there are differences in students' critical thinking and science process skills using the discovery learning model combined with animated video media.

Table 1 T-Test Results Data on Critical Thinking and Science Process Skills

T-Test	Sig[2-tailed]	Criteria	Decision H_0
Critical Thinking	0.033	Sig. < 0.05	Rejected
Science Process Skills	0.048	Sig. < 0.05	Rejected

4 Discussion

4.1 Critical Thinking

Table 2 Discovery Learning Syntax with Critical Thinking

No	Critical Thinking		Discovery Learning Syntax
	Aspect	**Sub Critical Thinking**	
1.	Interpretation	Define meaning	Orientation
2.	Analysis	Identify arguments	Hypothesis generation
		Analyze arguments	
3.	Evaluation	Assessing claims	Hypothesis testing
		Assessing the quality of arguments by inductive and deductive reasoning	
4.	Inference	Making estimates/temporary answers	Conclusion
		Conclude	
5.	Explanation	Present arguments	Regulation
6.	Self-regulation	Self-monitor	
		Self-correct	

Source: [12]

The results of the T-test show that there are differences in critical thinking in class using the discovery learning model combined with animated videos and in the class only using discovery learning. The application of interactive video-assisted discovery learning is effective in improving students' critical thinking compared to only the application of the discovery learning model [11]. The learning process that applies the discovery learning integrated with video makes students interested to participate in learning so that students are more focused and student's critical thinking will be optimally used. Showing animated videos stimulates students to create a developing mindset in dealing with the information obtained in the video. Animated videos as learning media can be used as material for students to conduct investigations along with discovery learning.The discovery learning syntax consists of 5 stages that is orientation, hypothesis generation, hypothesis testing, conclusion, and regulation. The stage of discovery learning can train students' critical thinking [12].

Interpretation is trained at the orientation stage based on the belief that to think in a complex manner requires a mastery of basic knowledge, therefore the teacher displays terms, meanings, and the basic framework of the material [13]. The difference in critical thinking in the class with the use of discovery learning combined with animated videos compared to classes with the only use of discovery learning is students can recognize and describe problems better. The stimulus is in the form of an animated video that can visualize an abstract phenomenon more clearly. The image media used in the class with the application of discovery learning doesn't stimulate students' interpretation power, so the ability to recognize a problem is less than optimal.

The discovery learning orientation stage is the process of building initial ideas to explore knowledge and identify materials. Students in classes using discovery learning combined with animated videos are faced with something that raises their curiosity that is making observations from animated videos. The teacher doesn't immediately give generalizations about the video, but the teacher asks students questions to identify problems from the video that has been shown. Animated video is used as a stimulus to arouse students' curiosity and thinking ability.

Orientation is the beginning of learning that requires students to make observations to investigate a learning topic. The investigation is carried out by exploring existing phenomena to stimulate students' curiosity [14]. Interpretation is students' ability to provide arguments related to the data or phenomena in the animated videos that are displayed [12]. The use of animated videos can affect students' understanding because they can see a phenomenon directly even though it is in the form of moving animation. This makes students have better learning experiences and thinking abilities than before [11].

Classes with the use of discovery learning models without any stimulus through animated videos, but by using pictures. The presentation of images contains a few elements of the message that will affect the level of readability of the message for students. The more material that is conveyed through pictures, the more difficult it will be for students to capture the message conveyed [15]. The animated video used in the experimental class displays messages in the form of images, sound, and text in the form of animation so that they can live in a video [16]. Animated videos contain more messages and attract students' attention than ordinary picture displays.

Analyzing is a process of connecting various information to make a statement or argument. Students at the stage of hypothesis generation make a hypothesis from a problem that has been formulated previously. This stage encourages students to connect ideas, previous understandings, experiences, and personal opinions [12]. Students are more active in the hypothesis generation stage to express answers to the problem formulation and exchange opinions with other students. Students in the class using the discovery learning model combined with animated videos were more active in suggesting answers to the problem formulation than the class only using the discovery learning model with a ratio of 8:5 students.

The ability of students to evaluate is to explain a problem logically. Students at the hypothesis testing stage arrange activities to prove the correctness of the temporary answers that have been made previously. Activities carried out by students are designing evidence, carrying out evidence, and interpreting data from evidence. The proof is done by studying literature in groups, then the results of the literature study are discussed by students for analysis. The results of the evidence with group discussions are presented in front of the class. If there is one group that presents the results of the discussion, then other groups can help provide input on the results of the discussion or correct it, so that communication occurs between groups [13]. Classes with the use of discovery learning models combined with animated videos have more students who give opinions that an average of 7 students. Students in the class only use the discovery learning model giving an opinion that an average of 5 students.

The inference is done by determining the parts needed to conclude and reviewing relevant information from a piece of evidence [12]. The conclusion stage is where the students are assisted by the teacher to draw conclusions based on the findings of the material that has been studied. Students can conclude the results of the evidence carried out according to the hypotheses that have been compiled or identify differences from the results of the proof with the hypothesis [17] [12]. The conclusion stage aims to encourage students to find evidence from the results of the analysis and determine possible conclusions [12].

The explanation is a process of stating the results of thinking based on existing evidence, this process is useful for ensuring student responses in understanding the material [12]. The teacher in the experimental class ensures the student's response in understanding the material by explaining with animated video so that students gain reinforcement of the material from the results of the previous discussion. The control class with only used discovery learning gets an explanation from the teacher in the form of pictures, so it can be seen that the explanation aspect in the class with the use of discovery learning combined with animated videos is higher than the class with the only use of discovery learning.

Self-regulation is a process of applying self-analyzing and self-evaluating [12]. Self-regulation is students can correct their abilities after arguing for future improvements [1]. The teacher responds to the results of student discussions and provides further explanations about the material at the regulation stage. Material reinforcement from the teacher in the experimental class was delivered through animated videos, while in the control class it was through pictures. The use of videos can help teachers in describing abstract material concepts so that they are more easily understood by students [18]. Visualization of abstract concepts will more easily provide new knowledge to students, so that critical thinking, problem-solving, and interest in learning can increase [19].

4.2 Science Process Skills

The results of the T-test showed differences in students' science process skills in the class using the discovery learning combined with video animation and in the class using only the discovery learning. Research on the application of multimedia-assisted discovery learning models to science process skills has results that students' science process skills are higher when taught with multimedia-assisted discovery learning models compared to classes taught only with discovery learning and direct interaction [20]. Modeling learning combined with experimental videos can significantly improve students' science process skills. The animated video can make students perform science process skills in the form of observing or making observations so that they can conclude the results [21]. Showing videos to students has the potential to be easy to remember by 50% while viewing pictures by 30% [22]. The use of video becomes part of visual learning that makes it easier for students to connect what is seen from the video with reality [21].

Practicing science process skills helps students to find knowledge independently through literature studies or by conducting experiments, therefore the material will be easier for students to understand and remember for a long time [23]. Discovery learning and science process skills have the same advantages, namely in investigation activities and concept discovery [24]. The stages in discovery learning support aspects of science process skills such as providing stimulation, identifying problems, collecting data, processing data, and concluding [25].

The difference in students' science process skills in the two sample classes was due to the more meaningful understanding obtained by students. The process of observing the animated video is the beginning of students constructing knowledge and learning experiences. Students observe animated videos that are delivered using the senses of sight and hearing as well as relevant facts. Students can have science process skills such as formulating problems, grouping based on similarities and differences, and communicating orally and in writing [26].

Students' science process skills in the concluding aspect are trained at the beginning of learning by providing a stimulus in the form of an animated video. Animated videos provide a stimulus so that students are interested in participating in learning and revealing what will be learned. Students' skills in summarizing the content of animated videos are emphasized in this stage. Students build conclusions from the overall material that has been studied at the conclusion stage. Students' skills in making conclusions both at the beginning and at the end of learning involve teacher guidance, namely through questions. Learning with discovery learning makes students actively involved in the class. Students not only memorize the material and take notes, but students actively think and make conclusions with the guidance of the teacher [24].

Students' skills in measuring are not directly taught in class, because the learning material is in the form of immune system material which doesn't allow students to take direct measurements. Students' skills in measuring are obtained from literature studies and experiences experienced in life. An example of measuring indicators is the use of tools to obtain data that students can learn from the surrounding environment, namely the tools used to check Covid-19 sufferers. The indicator measuring in appropriate units is obtained by students from their own experience when participating in the Covid-19 vaccination, students know the unit of dose of the vaccine given.

Students' skills in classifying are at the hypothesis testing stage. The activity of classifying students is carried out when grouping several types of disorders in the immune system and types of immunity. Classification is a skill to identify the properties that appear in an object or phenomenon, then grouped based on differences, similarities, and relationships [25].

The prediction skills support students' skills in hypothesizing [27], namely at the discovery learning stage of hypothesis generation. Students who have formulated problems from video shows, then try to make hypotheses. Hypothesis as students' skills in predicting possible answers. The hypothesis that has been made needs to be proven by conducting a literature study. The results of proving the hypothesis can be different or contrary to what students have predicted at the beginning. Increasing students' skills in making predictions will affect their ability to make hypotheses [28]. Students' skills in predicting must be based on existing patterns or data, so that in making hypotheses students answer with what has been known previously and from the handbook they have. Predicting shows students' skills in determining the possibility of an event or phenomenon. The discovery learning model helps students to think scientifically so that prediction skills will develop [25].

There is a fairly high difference in the aspect of communicating in the class with the use of animated videos compared to classes without animated videos. Animated videos present data in the form of charts with explanations that are easier for students to understand. Aspects of communication other than in oral form can also be done in written form [29]. Students' skills in communicating a problem in written form during presentations can help students transfer information. Displaying data on videos can train students to convey information well [27].

5 Conclusion

Based on the results of testing and discussion, this research concludes that there are differences in students' critical thinking using the discovery learning model combined with animated video media and there are differences in students' science process skills with the use of discovery learning models combined with animated video media.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no conflicts of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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