



STEM Approach in Online Lectures: How Does it Contribute to Cognitive Aspects?

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ABSTRACT

This research uses a STEM approach in online lectures on learning outcomes in biology learning innovation courses. This type of research uses a quantitative approach with a quasi-experimental method with a posttest only design with a nonequivalent group. The population of this study was the fourth-semester students of Tadris Biology UIN Sulthan Thaha Saifuddin Jambi in class VI B and VI C, which opened 18 people. Samples were taken by using a purposive sampling technique. The instrument in this study was in the form of 5 essay test questions. Data analysis used t-test and correlation test. From the results of data analysis with the t test, it can be concluded that online lectures using the STEM approach are much better than online lectures without using the STEM approach. Research analysis continued with correlation test, and it was found that lectures with a STEM approach had a significant effect on student cognitive domain learning outcomes.

Keywords: Online Lectures, STEM Approach, Cognitive Learning Outcomes

INTRODUCTION

Lectures in the industrial era 4.0 require a change in the paradigm and mindset of educators in conducting the lecture process, which requires educators to be able to conduct lectures effectively (Jabbar et al., 2021; Saha et al., 2021; Vosniadou et al., 2020) followed by technology making it easier to get information (Zb et al., 2020). Information easily obtained in the lecture process can maximize students' creativity and critical thinking (Hayes, 2015; Shute & Rahimi, 2021; Zandvakili et al., 2019). Modern educators aim at the best pedagogical abilities that create and at the same time provide a quality learning atmosphere (Lehavi & Eylon, 2018; Muwonge et al.,

2020). Good learning plays an essential role in conducting the lecture process to increase student enthusiasm in learning (Putra et al., 2021). Online lectures can provide solutions for changing the paradigm of lectures in today's modern era.

The online lecture process with the STEM approach is a strategy in improving the lecture process amid a pandemic, which provides opportunities for students to think critically so that they gain complete knowledge (Hayes, 2015; Robinson, 2020; Zandvakili et al., 2019). An easy process of gaining knowledge via the internet can support the online learning process and with a STEM approach where the lecture process will provide a better understanding and not out of date (Chen et al., 2019; M. A. Honey et al., 2014; Zb et

al., 2020). Online lectures using the STEM approach amid a pandemic are an opportunity to provide a breakthrough in improving critical thinking skills that can motivate students to deepen their lecture material. The online learning process with the STEM approach can be a lecture transformer (Sulman et al., 2020, 2021) in facing a more complex future, thereby encouraging student effectiveness in studying lecture material (Abdillah, 2017; Heinrich et al., 2015) so that it can open broader knowledge and can be a new change in the lecture process. The STEM approach is a highly integrated effort in solving a problem (Brears et al., 2011; Chen et al., 2019; Margot & Kettler, 2019; Trueman, 2014), which can shape students to become more independent and ready in changing times.

The online lecture process that is happening now is very different from what is expected (Sulman et al., 2021; Zb et al., 2020), where there is no integration of knowledge that is considered important, especially in biology learning innovation courses. Biology learning innovation courses should make a paradigm shift, where the innovation process provided must be able to be integrated with other knowledge so that prospective teachers while in the field can later provide appropriate and maximum and effective solutions (Sulman et al., 2021; Zb et al., 2020). The learning process with the STEM approach in online lectures can help students have high critical thinking skills, which make students more interested in understanding the material more deeply so that their learning outcomes are better and more meaningful (Putra et al., 2021; Shaw, 2014)

The lecture process that has been carried out shows that there are obstacles in the lecture process; students are never faced with essential questions during the lecture process. Project-based lectures have never been carried out, so that in testing learning outcomes consistently.

Low, because this indicates the importance of STEM in lectures, especially amid an online pandemic like today. The analysis of the lectures above, both in terms of theory and practice, identifies the need for a change in lecture changes, especially in online lectures in the midst of a pandemic (Putra et al., 2021; Sastradika et al., 2021; Zb et al., 2020). The lecture process must be able to improve students' critical thinking habits so as to improve learning outcomes for the better and not be left behind with changing times (Chen et al., 2019; Sulman et al., 2021; Wan et al., 2020). In fact, the STEM approach in online lectures in the midst of a pandemic has not been much specifically on the cognitive aspect, and the researchers have not found in the Biology learning innovation course, so this is the basis for researchers to conduct research in investigating the STEM approach in online lectures which is specifically reviewed on cognitive aspects.

RESEARCH METHOD

The study used a quantitative approach through a quasi-experimental method with a posttest only group design with a nonequivalent group design. The design of the study can be seen in Figure 1.



Figure 1. Research Design The Posttest Only Design With Nonequivalent Group (Creswell, 2012).

The study was conducted by two different lecturers where the treatment (X) was carried out by researchers in the experimental class (O₁) with online lectures with a STEM approach. In contrast, the control class (O₂) with online lectures directly corresponded to the lecturer who taught. The population in this study were fourth-semester students in

2020/2021 with four classes at UIN Sulthan Thaha Saifuddin Jambi. Samples were taken through the purposive sampling technique. The number of students in this study was 18 students normally distributed and had a homogeneous variance. Nine students were assigned as the experimental class (IVB) and nine as the control class (IVC). Classes are taken in the study follow actual class conditions without separating and distinguishing between levels and genders. In the data collection process, the instrument used is in the form of a final test assessment (posttest).

Analysis of Instrument Devices that is learning plans and test questions in the study carried out logical validity consisting of 3 lecturers with test instruments in 5 essay test questions, where the indicators of the cognitive test questions used are according to Anderson's taxonomy, namely C4 (analyzing), C5 (Evaluating) and C6 (Creating). In addition to the logical validity of the expert. The results of logical validity obtained data that the instrument can be used in the biology learning innovation course. In contrast, for the learning outcome test instrument, it can be concluded that five essay questions are suitable for use. The analysis was carried out to see how online lectures using the STEM approach on student learning outcomes uses two types of methods, namely the t-test method and the phi correlation test method. Analysis with the t-test is used to see how the comparison of two variables affects learning outcomes. At the same time, the second method, namely the phi correlation technique, is intended to determine the significance of the STEM approach in online lectures in influencing student learning outcomes amid the Covid-19 pandemic.

The principle of the difference and correlation test that has been carried out is preceded by a prerequisite test to see the accuracy of the instrument's decision by using normality and homogeneity tests. Analysis The homogeneity test was carried

out using the chi-square test X^2 , while the F test was used to see whether the variance of the sample group was homogeneous or not. From the analysis of prerequisite, tests obtained uniform and homogeneous data, so the decision was taken to perform the t-test and phi correlation to see the difference and the significance of their effect on the learning outcomes of biology learning innovations.

RESULT AND DISCUSSION

The data of the assessment findings obtained from the analysis of the final test in the form of student learning outcomes with the type of question used is a description, the value of student learning outcomes seen is student learning outcomes in the cognitive domain. aspects both in the experimental class and in the control class in the biology learning innovation course

Findings Related to Learning Outcomes

The research findings in the form of final test assessments obtained data from the final test (posttest); the questions used were five essay questions. The research process wants to see the value of student learning outcomes that are seen in the cognitive aspect, as shown in Table 1.

Table 1. Posttest scores of learning outcomes

No	Parameter	Experiment	Control Class
		Class	Class
		<i>Posttest</i>	<i>Posttest</i>
1	Number of students	9	9
2	Lowest Score	75	70
3	highest score	90	80
4	Average score	85	75

Based on the data in table 1, it is found that the average score in the experimental class is better than the control class. The analysis process is continued with prerequisite tests to answer the research hypothesis, namely whether there are

differences in learning with the STEM approach to learning outcomes and whether it has a significant effect on student learning outcomes.

The analysis of the Prerequisite Test that has been carried out in the form of a normality test and a homogeneity test is carried out by taking the final test data for the treatment given to biology learning innovations. The results obtained are the normality test in the experimental class with a value of $\alpha = 0,05$ or 5% the results obtained are $X^2_{count} \leq X^2_{table}$, $14,254 \leq 16,9190$ then the experimental class data is normally distributed while the control class $X^2_{count} \leq X^2_{table}$, $14,254 \leq 16,652$ can be stated data as well normally distributed. Homogeneity test using a significant level $\alpha = 5\%$ then we get the value $X^2_{table} = 1,72$ and $X^2_{count} = 1,45$. So it can be concluded that $X^2_{count} \leq X^2_{table}$ so that a conclusion can be drawn that the data variants are homogeneous, which then becomes the basis for determining the research analysis followed by the t-test as shown in table 2.

Table 2. Test of differences in learning outcomes (t-test)

No	t test Value		Comparison of t Test Values	Conclusion
	t _{count}	t _{table}		
1.	5,36	1,73	$1,734 \leq 5,36 \geq + 1,734$	H₀ is rejected and H_a is accepted

Based on the results of the analysis with a df of 18, the t_{table} value was obtained at a significant level of 5% = 1,73. While the value of t_{count} = 5,36. Thus H_a is accepted, and H₀ is rejected, which means that there are differences between online learning and the STEM approach to

student learning outcomes in the control class. The research analysis process is continued by looking at the significance of the influence of the STEM approach in online lectures on learning outcomes in the eyes of biological education innovation using analytical techniques with the phi correlation test with the values obtained as Table 3.

Table 3. Phi Correlation Test

No	phi test Value		Comparison of r Test Values	Conclusion
	r _{count}	r _{table}		
1.	0,632	0,443	$0,443 \leq 0,632$	H₀ is rejected and H_a is accepted

Based on the calculation results, the correlation value of phi = 0,632 is that r_{count} is greater than r_{table} at a significance level of 5% equal to 0,4438. Then $r_{table} \leq r_{count}$ OR $0,443 \leq 0,632$. The STEM approach in online lectures amid the covid 19 pandemics significantly influences learning outcomes in biology learning innovations.

Discussion

This study aims to find out how the differences that occur during online lectures with the STEM approach are and how significant the effects are in influencing student learning outcomes in biology learning innovation courses. The implementation of online lectures expects an independent and effective lecture process (Farrokhnia et al., 2019; Zb et al., 2020); The critical thinking process aims to maximize learning outcomes, which must be changed because students must

have a paradigm that lectures are a way to gain knowledge (Sulman et al., 2021).

The process in online lectures requires encouragement to be more critical and selective in choosing information (Shaw, 2014; Zandvakili et al., 2019; Zb et al., 2020). Students who have a critical thinking pattern are believed to have the willingness to want to dig deeper into the information they get and strengthen their understanding of the process of delivering lecture material (Heinrich et al., 2015; Lawson et al., 2015) therefore, it is very important in online lectures. It takes a STEM approach to trigger student learning creativity to be good in biology education innovation lectures.

The critical thinking process in online lectures is a solution to maintain student focus in lectures, which indirectly creates seriousness in students' personalities during the lecture process (Craft, 2003; Shaw, 2014) controlled in the 21st century, all of which have been structured into a STEM approach. The integrated critical thinking process makes students more active and motivated to understand better material that can be used in online lectures.

The Effect of the STEM Approach in Online Lectures on Student Cognitive Learning Outcomes

The research process that researchers have carried out is fact-based on the results of the data that has been analyzed, and a meaningful conclusion can be drawn, where there are differences in student learning outcomes between the experimental class and the control class. The difference is due to a treatment (Putra et al., 2021; Sulman, 2019), where the treatment in the experimental class uses the

STEM approach while the control class does not. The lecture process in the experimental class that is more focused and integrated can lead to critical thinking, thus raising awareness for students to understand and provide a more profound analysis of lecture material (Zb et al., 2020). The lecture process with the STEM approach is a solution to avoid saturation in the lecture process. The STEM approach's lecture process increases curiosity about the material being presented by the development of science. Students become motivated in getting an understanding and information so that the lecture process can be carried out and run more optimally than the control class.

The difference in learning outcomes in the control class is due to the lectures being a bit monotonous, causing student boredom. In the lecture process in the control class, under certain conditions, students' critical thinking abilities are encouraged to move, so that a psychological condition occurs for students not to need to understand the material more deeply (Sulman, 2019; Sulman et al., 2021). The lecture process without using the STEM approach in online lectures can be a catalyst for assuming that lectures are not too important to do even though online lectures provide a large space in finding more information that should be maximized to add insight in understanding the subject matter (Zb et al., 2020). Lectures with a STEM approach are the best way to improve innovation in biology education by increasing students' understanding of innovation materials.

The findings obtained in the field are by several studies which state that the STEM approach can be a solution in modern learning both online and offline

(Basham & Editor, 2010; M. Honey et al., 2014; Robinson, 2020), which can provide conditions for focused and focused in the learning process. The lecture process with an online STEM approach is a solution for students with biology learning innovation courses to prioritize creativity (Chen et al., 2019; Hernández-Torrano & Ibrayeva, 2020). The process in lectures with the STEM approach can enable students to think critically to understand better the material given because they realize that in the world of education it is constantly evolving, so an innovation such as STEM is needed that can think critically for students and in fact from research results that there are differences in results. Student learning, where the experimental class using the STEM approach in online lectures gets better cognitive learning outcomes wherefrom the cognitive test questions given, students seem to be able to analyze (C4) the problems given, are able to evaluate and assess (C5), namely, in answering questions, they are able to make a criterion and point of view of a learning innovation with good standards and quality and are also able to innovate or create (C6) a plan, or a new strategy and be able to develop an innovation in biology learning.

The Significance of the STEM Approach in Online Lectures on Student Learning Outcomes in the Cognitive Domain

The data analysis that has been carried out provides that lectures using the STEM approach in terms of cognitive aspects have a significant impact. The lecture process using the STEM approach provides direction for students to feel and believe they can become a creator or

innovators (Margot & Kettler, 2019; Robinson, 2020). Lectures with the STEM approach have become a trend in world education because many studies have concluded that STEM can improve the quality of the learning process, with very satisfying results (Chen et al., 2019; Collins, 2018; Margot & Kettler, 2019; Mullet et al., 2018; Robinson, 2020).

The study explores the findings by conducting an interview process with all students, namely nine people in the control class and nine in the experimental class who attended lectures on two lecturers who taught biology learning innovation courses. Interviews that have been conducted related to the process during lectures, innovation learning biology is taught during the pandemic, especially regarding the advantages and disadvantages of the lecture process. In the interview process, the focus is on what triggers students during lectures. The results of interviews in the experimental class obtained information that students were motivated to explore deeper information. They always tried to innovate in finding the best solution and always tried to improve and prepare themselves as inventors in the form of innovation as new knowledge. The learning process with the STEM approach can generate very high enthusiasm for students in finding a solution to a problem (M. A. Honey et al., 2014; Tatus et al., 2014; Trueman, 2014), thus instilling in them that they can provide the best solution in solving problems, especially the teaching and learning process and inversely proportional to the control class, which is a slightly dull online lecture process.

The interview process that has been carried out provides interesting facts,

wherein the control class students can still increase their independence in finding a lot of additional information. However, because the material provided is similar to ordinary lectures, the process that requires students to be critical and creative is not facilitated. Moreover, they are not given the opportunity to be able to innovate in biology learning which results in low learning outcomes in the cognitive domain of students. Learning outcomes in the control class provide a point of view that appropriate learning in the learning process can improve students' cognitive learning outcomes (Chen et al., 2019; Margot & Kettler, 2019; Zb et al., 2020). Researchers who have done this concluded that lectures with a STEM approach could be the right solution in online lectures (Robinson, 2020; Trueman, 2014). The learning process with the STEM approach can encourage students to think critically and bring up the best innovations in biology learning so that learning outcomes are better in students' cognitive learning outcomes. This is in accordance with the facts found in the field where the STEM approach in online lectures has a significant effect on student learning outcomes in the cognitive domain, especially in the biology learning innovation course.

CONCLUSION

The research that has been carried out has obtained several facts. From the analysis of the data with the t-test, it was found that there were differences in student learning outcomes between the experimental class and the control class. Online lectures with a STEM approach produce better learning outcomes in the cognitive domain. In line with this, the

results of the analysis using the phi correlation test show that learning with the STEM approach has a significant effect on influencing online learning outcomes amid the covid-19 pandemic in learning innovation courses. As for research suggestions for further researchers to be able to integrate STEM with Art, or commonly referred to as STEAM, this is so that students are not only strengthened by critical thinking but also by art in innovating. The research results that have been carried out are expected to be a reference for other researchers in researching the future because STEM can be proven to be the right solution in integrating complete knowledge to follow the best educational pattern and not be out of date. The facts presented are valuable information so that other researchers can also apply the STEM approach to biology education innovation subjects and other biology courses in particular and education courses in general, both amid a pandemic or in a new normal situation.

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