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E-Learning Integrated Active Learning Strategies to Improve the Critical Thinking Skills

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Abstract. Physics learning is expected to provide students with the provision to grow and improve critical thinking skills. Learning that is suitable for improving critical thinking is an active learning strategy that is integrated with e-learning. The results of previous studies indicate that college students' critical thinking skills are in low category. This study aims to analyze the improvement of students' critical thinking skills through active learning strategies. The active learning strategies used are Reading guides, Concept Mapping Strategy, and Information Search Strategy. The design of this study used posttest only control group design. Students' critical thinking skills are measured using 6 essays and through student worksheets. The results showed that critical thinking skills of experiment group were higher than control group.

1. Introduction

Critical thinking must be owned by every graduate of the Undergraduate Program. This is stated in the Regulation of the Minister of Education of the Republic of Indonesia Number 3 of 2020 concerning National Higher Education Standards which states that graduates of the Undergraduate Program must have general skills, namely being able to apply logical, critical, systematic, and innovative thinking in the context of developing or implementing science and technology, who pay attention to and apply humanity's values in accordance with their field of expertise.

Critical thinking is an intellectual value that is very important for students before entering the world of work and life that is constantly changing [1–3]. Critical thinking skills also train individuals in choosing the best solution to a problem. Various efforts to solve problems, make decisions, analyse assumptions, and scientific findings must be based on critical thinking skills. students who think critically become more active, sharp, and sensitive to information and the conditions they face and are polite in their actions[4–7].

The era of globalization requires critical thinking skills in overcoming various problems. Information exchange is very fast in this era. Therefore, individuals must be able to analyse the information they receive. Problems in the era of globalization are also increasingly complex so that critical thinking will lead individuals to make decisions or solve the most appropriate problems [8]. The ability to think critically is one of the things that need to be considered in order to produce university graduates who can meet global requirements [9–14].

The importance of critical skills for students does not make these skills really develop in the lecture process. In fact, various research results show that students' thinking skills are still unsatisfactory [15]. The low critical thinking skills are also caused by the lack of training in various scientific problems, limited learning resources, perceptual bias, and learning time that limits the development of students'



thinking. In addition, students are used to memorizing and mastering only a few concepts. Students also lack basic knowledge, making it difficult to solve problems and find alternative solutions to problems [16–18].

There are countless experts who study this skill. Facione stated that more than 1,100 studies show that critical thinking skills in tertiary institutions are significantly correlated with students' Grade Point Average [7,19]. This statement shows that there is a significant relationship between critical thinking and reading comprehension. Regardless of the college experience, students must study independently, think, and make their own contributions to society.

Facione has the view that “critical thinking in term of cognitive skills in interpretation, analysis, evaluation, inference, explanation and self-regulation.” Critical thinking is a term of interpreting, analysing, inferring, explaining and self-regulation. This is in accordance with Dewey's opinion which argues that “critical Thinking is an attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one's experience, knowledge of the methods of logical inquiry and reasoning, and some skill in applying those methods. In other words, critical thinking is the act of following the scientific method of understanding something [20,21].

Various attempts have been made to practice these skills in the learning process, but the results have not been significant. This is because the efforts that have been made have not focused on student learning activities [22,23]. Learning can only be understood if there are activities in the learning process. Active learning strategies can be used to overcome this problem. Active learning strategies are one of the strategies used to optimize the learning process, where the teacher is a person who creates a conducive learning atmosphere or as a facilitator in learning, while students must be active, innovative and the environment is used as a creative, effective and attractive learning resource [24–26].

Active learning is intended to optimize the use of all the potential that students have, so that all students can achieve satisfactory learning outcomes according to their personal characteristics. In addition, active learning is also intended to keep students' attention so that they are focused on the learning process [23].

Active learning can then be integrated with online learning which is very flexible and the media that can be used are very diverse. The advantage of e-learning based learning is that we can integrate many supporting simulations which are very helpful in teaching abstract physics concepts, such as electricity and magnetism [27,28]. The Faculty of Mathematics and Natural Sciences at the State University of Makassar has an excellent, bold learning system that supports a wide variety of online learning. Internet-based learning is one of the most popular manifestations of e-learning, which offers various benefits such as more flexible learning opportunities without being bound by time and space, making it easier for students to access education, enriching learning materials, animating the learning process, making the learning process more open, improving learning power, as well as supporting students to learn independently [27–30].

In order for the active learning process to run well, educators as a driving force for student learning are required to use and master active learning strategies. There are many learning strategies ranging from simple to complex. However, among the many active learning strategies, there are at least three strategies that can be integrated into online learning, including: Reading Guide Strategies, Concept Mapping Strategies, and Information Search Strategies [23,24,31–33]. From this description, the researcher then tries to see how active learning strategies integrated e-learning can improve critical thinking skills.

2. Experimental

This study aims to look at students' critical thinking skills when taught with integrated e-learning active learning strategies. The research subjects were two classes consisting of 38 students of the Physics Department of State University of Makassar, South Sulawesi. The subject chosen are third year undergraduate students who are programming electricity and magnetism courses. This study was conducted once. The method used is post-test only control group design. The research instrument used

in the form of 6 essays with critical thinking indicators, namely: interpretation, analysis, and inference skills. The description for each indicator of critical thinking skills which is made into question indicators can be seen in the Table 1 [6,7,34].

Table 1. Critical thinking skills indicators and descriptors

Indicators	Descriptors
Interpretation	<ul style="list-style-type: none"> • Collection of some data through observation • Detects data patterns based on the information collected • Declare relationship • Make a rational explanation based on the data collected
Analysis	<ul style="list-style-type: none"> • Use scientific knowledge and understand explanations and interpret observations, measurements or data patterns • Describe the consequences if one variable is missing
Inference	<ul style="list-style-type: none"> • Use scientific knowledge and understand explanations and interpret observations, measurements or data patterns. • Describe the consequences if one variable is missing. • Can be used as a tool to determine further observations.

The experiment was carried out by dividing the two classes based on the treatment in the online lecture process. The control class is given general online lecture directions, which are limited to conveying the course objectives, delivering material, discussing, previous assignments, and carrying out a learning procession based on a scientific approach that is usually done in offline lectures. Meanwhile, the experimental class was given a student activity sheet that supports activeness through active learning strategies.

Active learning strategies are applied through student activity sheets developed by researchers. Active learning strategies implemented are Reading Guide Strategies, Concept Mapping Strategies, and Information Search Strategies. The form of strategy implementation that has been carried out has gone through many considerations, including the capabilities and limitations of online learning that is not accompanied by face-to-face learning, so the self-directed learning method is very much needed.

The self-directed learning method applied is not only limited to directing students to read textbooks, but is accompanied by directions on what material to read (Reading Guide Strategy), accompanied by an illustration of mapping concept sequences and giving the right keywords (Concept Mapping Strategies), and accompanied by image links to well-known textbooks through illustrations that require students to search for information from the book in question (Information Search Strategies). Display of student activity sheets based on e-learning integrated active learning strategies can be seen in Figure 1.

To determine the level of critical thinking skills of students, the researchers used two methods. The first is by looking at the results of filling in the answers from the student activity sheets that they have uploaded in the online learning system of Makassar State University. The second is through giving critical thinking skills tests on electric and magnetic materials. The percentage of critical thinking skills test scores are categorized into three levels with the intervals shown in the Table 2.

Table 2. Critical thinking skills category based on the percentage of the test score

No	Percentage	Category
1	$\leq 30\%$	Low
2	$30\% \leq x \leq 60\%$	Medium
3	61% - 100%	high

The student activity sheet based on the e-learning integrated active learning strategy used in this study has met the educational, construction, and technical requirements of a good activity sheet. The most vital thing from this activity sheet is the construction requirements, including: using language appropriate to the student's maturity level; using a clear sentence structure that has a sequence of

lessons in accordance with the level of student ability; avoiding overly open questions; does not refer to source books outside the readability of students; provide sufficient space to provide flexibility for students to write and draw; use simple and short sentences; uses more illustrations than words; have clear learning objectives. Based on the expert's assessment, the worksheets used meet these requirements.

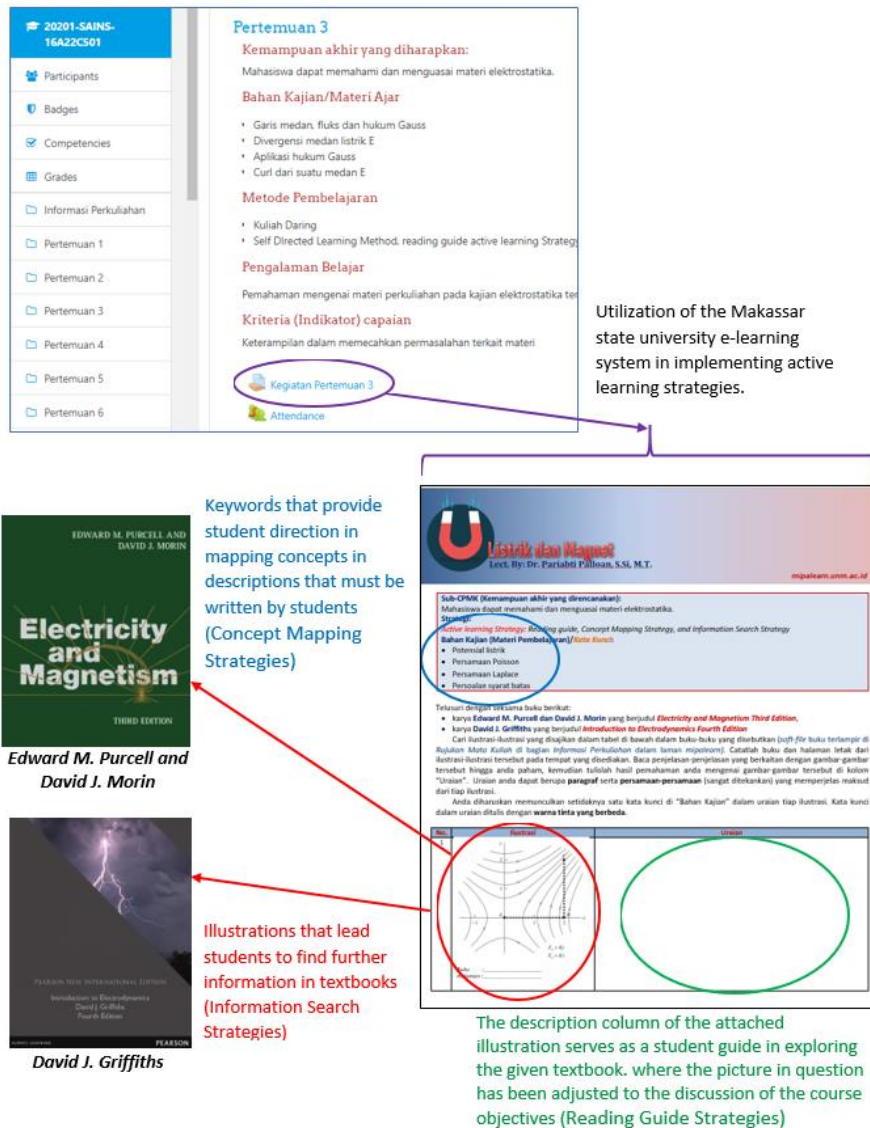


Figure 1. Display of student activity sheets based on e-learning integrated active learning strategies

3. Result and Discussion

The results of measurements using tests of critical thinking skills can be seen in the Table 3, where the measurement results are separated for each indicator.

Table 3. The percentage of critical thinking skills scores for each indicator

Indicator	Control	Experiment
Interpretation	53.61	73.06
Analysis	66.11	68.06
Inference	46.11	62.50
Total	55.28	67.87

The results shown in Table 3 are then presented in a graph shown in Figure 2. It can be seen that overall, the critical thinking skills of the experimental class are better than the control class. When viewed based on the indicators, it can be seen that the interpretation skills and inference skills are much higher for the experimental class than the control class. However, for the analysis indicator, the control class and the experimental class did not show any striking differences.

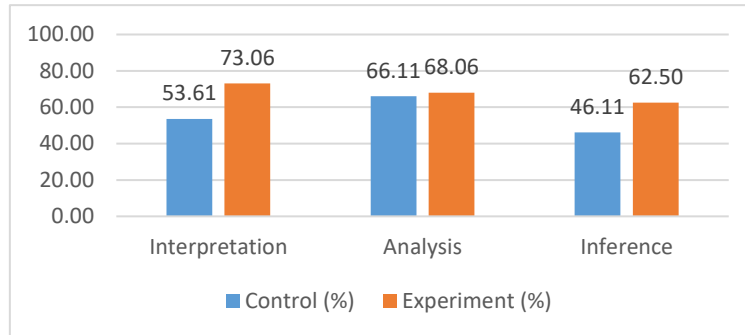


Figure 2. Percentage of Critical Thinking Skills

Basically, if we look at the scores for the acquisition of students' critical thinking skills, it is already in the medium category. However, this is still considered unsatisfactory, considering that the students who are the research subjects are already in the 5th semester. Therefore, this skill improvement is still considered necessary. It can be seen from Figure 2, that the experimental class has given a percentage of scores that are in the high category.

The results described here are still based on the results of critical thinking skills tests. The impact of the active learning strategy that is implemented can be seen clearly through the students' answers in the given activity sheets. The following is explained for each indicator.

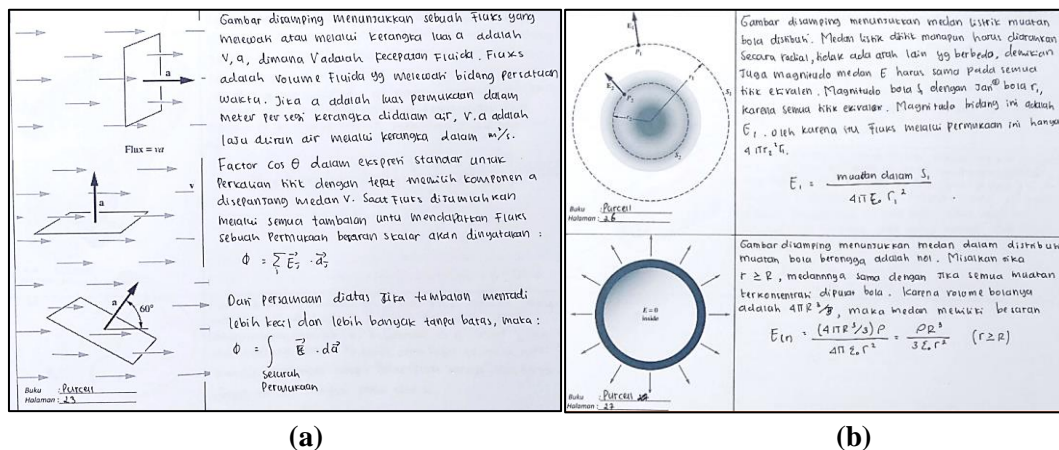


Figure 3. (a) a sample answers to student activity sheets that reflect interpretation skills. (b) a sample answers to student activity sheets that reflect analysis skills

3.1 Interpretation

Experts mostly define it as follows: interpretation is "understanding and expressing the meaning or significance of various experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures, or criteria". Interpretation includes sub-skills of categorization, decoding significance, and explaining meaning [2,7,11,17]. The learning material in this study is part of a series of electricity and magnetism courses, where when the treatment is carried out, the related material is electrostatics, which explains the field and interactions of charged objects when their motion (dynamic process) has not been linked in the discussion. Figure 3a shows an example of the answers to the student activity sheet which shows the level of student interpreting skills.

The illustration on the left of the Figure 3a shows three different situations regarding the normal vector direction of a cross section with respect to the direction of the linear electric field. The illustration is then observed and guides students to see the relationship between the angle formed and the electric field flux. The process that students go through in order to be able to write answers like in the Figure 3a is: students must first look for information in the textbook and see what variables can be collected in the illustration; students then detect the tendency of the data collected from the three images; students then explain the rational relationship of the variable in question. This repetitive process is carried out every meeting in lecture activities and assignments, so that students' interpretation skills are very well trained through a designed active learning process.

3.2 Analysis

Based on the definitions of many experts: analysis is "to identify the desired and actual inferential relationship between statements, questions, concepts, descriptions, or other forms of representation intended to express beliefs, judgments, experiences, reasons, information, or opinions." Experts also study ideas, detect arguments, and analyse arguments as sub-skills of analysis [1,7,12]. Figure 3b shows an example of the answers to the student activity sheet which shows the level of student analysis skills.

The illustration on the left of figure 3b shows two types of non-conducting sphere images, one image shows a non-conducting sphere whose charge is evenly distributed in the volume of the sphere, one image shows a non-conducting sphere whose charge is only distributed on its surface. Students then browse the textbook to understand the differences between the two images. Students can write down the answers like in Figure 3b if students go through the following process: students make observations and interpret several variables through the two images presented; students then understand that the difference in visible characteristics is due to a variable that has been changed or eliminated (in the figure, namely the density and distribution of the charge on the sphere). The process of student activity is very clearly able to improve student analysis skills.

Based on the results of the critical thinking skills test that has been done (picture). It can be seen that the analytical skills do not differ at all between the control and experimental classes, this is due to the characteristics of the test items for analysis indicators that are too full of related material, where in active learning that is applied very little in practicing mathematical problem solving skills.

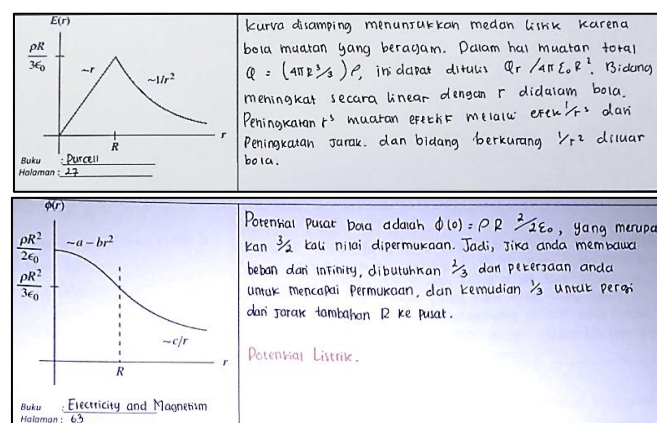


Figure 4. A sample answers to student activity sheets that reflect inference skills

3.3 Inference

Most experts define evaluation activities as follows: "the activity of assessing the credibility of a statement or other representation which is a record or description of a person's perception, experience,

situation, judgment, belief, or opinion; and to assess the logical strength of actual or desired inferential relationships between statements, descriptions, questions, or other forms of representation.” [2,6,7,11] Figure 4 shows an example of the answers to the student activity sheet which shows the level of student inference skills.

The illustration on the left of Figure 4 shows two curves. The first curve plots the relationship between the electric field and the distance from a point to the center of the non-conducting sphere. The second curve plots the relationship between the electric potential and the distance from a point to the center of the non-conducting sphere. Students can write down the answers as shown in Figure 4 if students go through the following process: students first explore through textbooks about variables that reflect the characteristics of the area around a charged object (in this case, the electric field and potential); students then try to interpret the meaning of the data presented in curves through certain points (such as the outer and inner boundaries of the sphere); Furthermore, students can then conclude or even predict how these variables will affect other variables (in this case, the magnitude of the field and the electric potential at the distance shown in the graph). If students continue to go through this procession while undergoing learning, it will greatly train their inferencing skills.

In fact, there have been several studies that explain how active learning affects critical thinking skills [35]. However, we need their application in online learning. From the results of this study it is clear that the active learning that we usually know can only be done in offline learning, it can also be applied in online learning, even being able to practice various kinds of skills, one of which is critical thinking skills as was done in this study.

4. Conclusion

The active learning strategy (Figure 2) which is applied through online learning in the e-learning system of the Makassar State University is very good in training students' critical thinking skills. This result can actually be improved if it is integrated through blended learning. Active learning that has been carried out in this research is also very helpful for students in understanding various kinds of concepts related to abstract things in physics.

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