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Students' Critical Thinking Improvement through *PDEODE* and *STAD* Combination in The Nutrition and Health Lecture

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ABSTRACT

Students' critical thinking skills are very important in the 21st century. Learning strategies can play a role in enhancing students' critical thinking skills in the Nutrition and Health lecture. The results of a survey in 2013 showed that the implementation of learning strategies had not given students the opportunity to practice their critical thinking skills optimally. The new strategy, a combination of *PDEODE* and *STAD*, can be used to overcome the occurring problems. The purpose of this research was to determine the increase in students' critical thinking skills in the nutrition and health lecture after they were taught using a combination of *PDEODE* and *STAD*. This was a pre-experimental research using a *one group pretest-posttest* research design. The samples of this research were one class consisting of 41 university students. The results of the test were analyzed with quantitative methods, by using statistical analysis, *paired samples T-test*, and to know the effectiveness using gain scores. The results showed that the significance was 0.000 ($p < 0.05$) and the gain score was 0.58. Thus, it can be concluded that the strategy of combining *PDEODE* and *STAD* can effectively improve the students' critical thinking skills in the nutrition and health lecture.

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1. INTRODUCTION

Students as part of society directly experience various social problems in their lives, and also problems related to communication with others about science. Therefore, students need to have critical thinking skills. Students who can think critically will be able to solve problems more effectively [1]. Furthermore, it is said that for students to have knowledge or information is not enough to be able to solve problems and to make decisions in life. Thus, the students require critical thinking skills. All college graduates are expected to become critical thinkers, who can make complex decisions quickly, act ethically, respect other people's ideas, and adapt to changes [2]. This situation shows that having critical thinking skills is necessary for students to face the challenges of the 21st century. Therefore, students need to be equipped with critical thinking skills in their learning activity.

Critical thinking is a complex concept consisting of multi-dimensional constructions involving cognitive skills and affective dispositions. Critical thinking is a complex concept including complex activity and mental processes which are not easy to be described and measured [3]. Some experts already defined the critical thinking. Critical thinking is the ability to give a reason in an organized way and to evaluate the quality of a reason systematically. Critical thinking is the ability to analyze and evaluate information, raise important questions, formulate problems clearly, gather and assess relevant information, use abstract ideas, think openly, and communicate effectively with other people [4]. Critical thinking as the kind of thinking

involved in solving problems, drawing conclusions, calculating the possibilities and making a decision [5]. Furthermore, it is said that the critical thinking includes a simple explanation, building basic skills, making a conclusion, giving more explanation, and setting strategies and tactics. According to Bloom's taxonomy, critical thinking occurs when students can perform at the level of analyzing, synthesizing, and evaluating [4].

Critical thinking skills must be given to students. Lecturers, as one component of the education provider at the university level, are responsible for equipping the university graduates with critical thinking skills [6]. It is essential that critical thinking skills should be taught in school because these skills are needed by students to be successful in their lives [7]. Thus, it is necessary to have a learning approach that equips the students with critical thinking skills. Thus, the components of critical thinking should be present in the learning process, in an effort to equip the students with critical thinking skills. A survey in 2013 on learning activities conducted by lecturers in Biology Education Study Program of Unirow Tuban, East Java, Indonesia showed that 6.7% of lecturers stated 6 students still had difficulty in using their critical thinking skills, and 83.3% of lecturers expressed that in the learning process the students did not dominate the learning activities [6]. This suggested that the students' critical thinking skills had not been optimally empowered. Most of the learning activities were still teacher-centered. The learning activities which still center on the teachers or the lecturers cannot develop the students' thinking skills. Therefore, it was required to make a breakthrough on the learning activities which emphasized on the students' critical thinking skills.

Students' thinking can be improved by using learning [8]. The development of critical thinking skills is best done in relation to the particular content or within a knowledge domain [2]. Therefore, the teaching of critical thinking skill should be integrated into the material of all study programs in various disciplines. Any teaching methods that train students to think critically, creatively, and systematically need to be used by lecturers either simultaneously or integrated into a learning subject [9]. One of learning subjects in Biology Education Study Program in the University of PGRI Ronggolawe Tuban, East Java, Indonesia is the Nutrition and Health. Therefore, critical thinking skills empowerment needs to be done in this learning.

The implementation of critical thinking needs to be achieved through learning strategies. Learning to develop the empowerment of critical thinking skills can be achieved through constructivist learning strategies, one of which is *cooperative learning* [10]. Cooperative learning is a pedagogic approach to encourage critical thinking and can be effectively used in lectures [4]. Constructivist learning places emphasis on the students finding information and building their own knowledge by themselves, from the results of their findings, and their previous experience. This is consistent with the constructivist theory that prioritizes new knowledge built on prior knowledge. Furthermore, this theory explains that the learning process always connects the prior knowledge with the material being learned [11]. John Dewey found that real learning comes from experience so that knowledge is gained from the transformation of experience [12]. In constructivist learning, the lecturer acts as a facilitator who guides and directs students to construct their own knowledge. The students will become active in learning, they will be socially collaborative, and they cooperate with peers so that they gain a deeper understanding of the knowledge. This suggests that the learning becomes students-centered.

Critical thinking skills can be developed through student-centered learning [13]. In this learning, the students will relate their knowledge with their everyday life. This learning is called as contextual learning. Contextual learning is appropriate to be implemented in the subject of Nutrition and Health because this course contains concepts related to everyday life. Contextual learning is able to develop students' critical thinking skills, by relating the material learned in the school with the context of everyday life [14].

One of the learning strategies using the constructivist learning approach is *Predict-Discuss-Explain-Observe-Discuss-Explain (PDEODE).* The *Predict-Discuss-Explain-Observe -Discuss-Explain (PDEODE)* strategy was first introduced by Savander-Ranne and Kolari in 2003, and was a modification of the *Predict-Observe-Explain (POE)* strategy [12]. The modification of *PDEODE* consists of additional learning activities that create an atmosphere that supports discussion, and the existence of a diversity of viewpoints [11]. *PDEODE* has six steps made up of components that support critical thinking in learning, namely, Predicting (P), Discussing (D), Explaining (E), Observing (O) Discussing (D), Explaining (E). The role of the lecturer in the *PDEODE* strategy is to challenge the students and to organize the discussion. In addition, the lecturer also asks questions to investigate and ensure that the students make their observations carefully and properly, and to try to ensure that the targeted concepts have been achieved [11]. The *PDEODE* strategy is an important strategy because it can support the discussion and the diversity of students' perspectives, so that it can help students make sense of the experience of everyday life [15]. Thus, it shows that *PDEODE* is a contextual learning.

PDEODE can effectively make the students understand everyday situations and changes in the concept of condensation, learning becomes meaningful and student-centered [15]. Thus, it can be used to empower students' critical thinking skills. *PDEODE* shows various components of critical thinking, namely analyzing, comparing, contrasting, communicating and criticizing the results of the discussion. Thus,

PDEODE can be used as a learning strategy to empower students' critical thinking skills. In addition, it creates a good atmosphere in the classroom, the cooperation between members of groups both during group discussions and during classroom discussions. Discussion method is an effective stimulus for developing critical thinking skills. The discussion is an effective way to develop critical thinking skills [16]. Besides, it appears to have cooperative learning. Thus, PDEODE is included in constructivist learning with cooperative learning type, so that it can improve students' critical thinking. Using PDEODE strategy to improve students' learning at the program of Environment Technique can be done through a research project [17].

However, the use of *PDEODE* has some weaknesses. Because the lecturers are not involved in the learning in the first step, students who are not familiar with independent-learning will have some difficulties. Another weakness relates to the discussion group divisions. The composition of discussion group members was not set, so that it tends to create an imbalance among the group members, disturbing the social interaction among friends. To overcome this, the researcher combined the *PDEODE* strategy with Student Teams Achievement Division (*STAD*). Student Teams Achievement Division (*STAD*) is one of the simplest models of cooperative learning that emphasizes interaction among students to motivate each other and help each other in mastering the subject matter, to achieve a common goal. The selection of cooperative learning strategies in the course of Nutrition and Health was necessary because the course of Nutrition and Health still had many difficult concepts. These difficult concepts can be solved by cooperation in the peer group discussion. Thus, a new strategy is needed, that is, the combination between PDEODE and STAD.

The combination of *PDEODE* and *STAD* is expected to improve the outcome of the *PDEODE* strategy. The combination of *PDEODE* and *STAD* is hereinafter called *PDEODESTAD* Strategy *(Predict-Discuss-Explain-Observe-Discuss-Explain-Student-Team-Achievement-Division).* The *PDEODESTAD* Strategy is a strategy that involves the students performing a mix of learning activities independently and learning in a group. It has eleven steps, namely, class presentation, predictions, group divisions, discussion, explanation, observation, discussion, explanation, quizzes/tests, assessments, and reward.

There have been several types of research on the use of PDEODE learning strategy. Indicate that PDEODE learning strategy is effective in increasing the students' concept gaining and concept change on the material of Evaporation so that it can reduce misconception [11]. The use of PDEODE with visualization and interaction has a positive effect on students' learning results and learning situation, increases students' motivation, improves learning, achieves a deeper understanding, and improves students' confidence [12]. There was a significant increase in the concept mastery of Nutrition and Health course after the implementation of PDEODE learning strategy of the students of Biology Education study program in Unirow Tuban [18]. Furthermore, PDEODE learning strategy has an effect on concept mastery and retention of Nutrition and Health courses of the students with different academic abilities in Biology Education Unirow Tuban [19]. However, there has not been any research on the implementation of the *PDEODESTAD* learning strategy, the combination of *PDEODE* and *STAD*, on students' critical thinking skills. Therefore, this pre-experimental research was conducted to investigate whether or not there was an improvement in the students' critical thinking skills on the Nutrition and Health Course after they were taught using the *PDEODESTAD* learning strategy.

The problem of this research was that the implementation of learning strategies used today had not been able to empower students' critical thinking skills optimally. The solution was by implementing a new strategy, PDEODESTAD learning strategy. This was a combination of PDEODE and STAD learning strategies. PDEODE strategy was based on constructivists, so that it could increase students' critical thinking. However, it still had some weaknesses. Thus, it was combined with STAD strategy as a solution. STAD is a form of cooperative learning strategy which, when combined with PDEODE, can improve the quality of learning and enhance students' critical thinking skills. PDEODESTAD strategy has eleven steps, namely class presentation, predictions, group divisions, discussion, explanation, observation, discussion, explanation, quizzes/tests, assessments, and reward. Problem-solving is given by implementing the PDEODESTAD strategy to improve critical thinking skill which is integrated with Nutrition and Health Course. The PDEODESTAD strategy can be used as an alternative for lecturers as an effort to improve students' critical thinking skills on the other subjects/courses. This study focused on the implementation of PDEODESTAD learning strategy to improve students' critical thinking skills in the lecture of Nutrition and Health and determined how big the increase of the critical thinking skill was after the pretest and the posttest.

2. RESEARCH METHOD

2.1. General Research Background

This was a pre-experimental research. This research aimed at investigating the improvement of students' critical thinking skills in the Nutrition and Health lecture after they were taught using the *PDEODESTAD* learning strategy. The design of this research used a *One-Group Pretest-Posttest Design*, that

is, an experimental research using one group without any comparison groups. This research was conducted twice, before the experiment (pre-test) and after the experiment (post-test) using one group of subjects. And to see how far the effectiveness of the treatment used gain scores, by looking at the magnitude of the increase in the critical thinking skills after the PDEODESTAD strategy was implemented, then an analysis was done to the gain score which was normalized as <g>, and then it was compared with the category proposed. The normalized gain score is the comparison between the actual gain scores and the maximum gain scores. The actual gain score is the score the students obtain, while the maximum gain score is the highest gain score the students possibly get. Learning is said to be good/effective if the normalized gain score is above 0.4. The research variables covered the independent variables, (PDEODESTAD), and the dependent variable (critical thinking skills). The type of this research is pre-experimental research.

2.2. Research Sample

The population of this research was all students of Biology Education, PGRI University of Ronggolawe Tuban, East Java, Indonesia, cohort 2012 in the fifth semester. The samples were taken by using purposive sampling. One class consisting of 41 students was divided into seven heterogeneous groups. Six groups consisted of six members and one group consisted of five members. They had similar background and knowledge about Nutrition and Health. The experiment began with a pretest and ended with a posttest.

2.3. Instrument and Procedures

The steps of the research covered three activities, namely: 1) Preparation, in the preparation stage, the syllabus, lesson plans, instruments, which had already been validated, were prepared, and the instruments were tried out, 2) Implementation, a pretest was conducted to know the students' initial critical thinking skills, and then the normality test was carried out to determine the normal distribution of the data. A posttest was conducted after the treatment had finished, and then the normality test was performed on the data of the posttest, 3) the data were analyzed by using paired T-test, normalized Gains score test, to answer the research problems as described in the background to this research. The data were analyzed by using SPSS for Windows Version 19.0. The instrument of critical thinking used an essay test and a rubric of critical thinking with the scale of 0-5.

2.4. Data Analysis

The data in this research were the scores of students' critical thinking skills based on the students' answers in the essay test. The data were obtained from the data of the pretest and posttest. The data were then analyzed by using paired T-test. Previously, the normality test was performed to determine whether the distribution of the data was normal or not. The normality test was performed by using *Shapiro-Wilk* and *Lilliefors.* H0 was rejected if the significance value (Sig) < 0.05 meaning that the sample distribution was not normal, and H0 was accepted if the significance value (Sig) > 0.05 meaning that the sample distribution was normal. All of the data were analyzed using SPSS for Windows Version 19.0 windows. Meanwhile, the gain score was analyzed manually.

3. RESULTS AND ANALYSIS

3.1. Result

The results of the normality test on the students' critical thinking skills using the Shapiro-Wilk and Lilliefors showed that the data were normally distributed (p > 0.05), as can be seen in Table 1.

Table 1. Results of normality test

Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Statistic	Df	Sig.	Statistic	df	Sig.
0.140	41	0.041	0.951	41	0.078
0.139	41	0.045	0.954	41	0.100

Source: primary data and calculations

The output results in Table 2 showed that the significance value of the Shapiro-Wilk column showed that the value of pretest was Sig 0.078 and posttest 0.100. Based on the above data analysis, because all the variables had a probability value > 0.05, it can be concluded that the data distribution of both the pretest and the posttest was normal.

The hypothesis testing used Paired t-test with the criteria of hypothesis testing. H0 was rejected if the significance value (Sig) <0.05 meaning that H1 was accepted. Thus, the implementation of the *PDEODESTAD*

strategy could improve critical thinking, and H0 was accepted if the significance value (Sig) > 0.05 meaning that H1 was rejected, thus the implementation of the *PDEODESTAD* strategy could not improve critical thinking. The test results of the Paired sample t-test to see the increase in critical thinking skills after the *PDEODESTAD* strategy had been implemented can be seen in Table 2.

Table 2. Results of paired sample t-test

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Xi - X2	-9.000	3.667	0.572	-10.157	-7.842	-15.714	40	0.000

Xi = pretest, X2 = Postest.

Source: Primary data and calculation

The output results in Table 3 show that the significance value of the Paired sample t-tests showed that Sig 0.000, Sig <0.05. Thus, H0 was rejected and H1 was accepted. It means that the implementation of the *PDEODESTAD* strategy can improve critical thinking skills.

To see the magnitude of the improvement from the pretest to posttest, the normalized gain score was calculated. The normalized gain is the proportion of absolute gain and maximum gain possibly achieved. The results can be seen in Table 3.

Table 3. Summary of N- gains scores.

The average score of pretest	The average score of Postes	Gains score	Classification	Decision
29.46	38.46	0.58	Medium	Above 0.4 Good / Effective

Table 3 shows that the gain score was 0.58, with moderate classification. Since the gain score was above 0.40, it can be concluded that the implementation of the *PDEODESTAD* learning strategy effectively improved critical thinking skills.

3.2. Discussion

The main objective of this research was to see whether or not there was an increase in critical thinking skills after the *PDEODESTAD* strategy had been implemented. The result can be seen from the statistical analysis in Table 3 that the significance value was 0.000. It indicates that the implementation of the *PDEODESTAD* learning strategy significantly improved the students' critical thinking skills in the subject of Nutrition and Health. The success of the *PDEODESTAD* learning strategy was because this strategy accommodated learning methods that could stimulate the improvement of critical thinking skills. This can be explained by the 11 steps of the *PDEODESTAD* strategy.

This can be explained at each step of *PDEODESTAD*; the first step of *PDEODESTAD* is a class presentation. In this activity, the lecturer gives a description of the learning objectives that have been set out in the lesson plan. The learning objectives are formulated to achieve the ability to analyze, synthesizing, and evaluating. According to Bloom's taxonomy, critical thinking occurs when students can perform at the skill level of analysis, synthesis, and evaluation [4]. In this step, the lecturer also explains about the procedure of the *PDEODESTAD* strategy to be applied. In addition, the lecturer explains the importance of active learning, and also provides the motivation for students to participate in activities to win in the group. Thus, the first step of *PDEODESTAD* meets the requirements to be able to lead to students' critical thinking.

This is followed by the second step, prediction. At this step, the lecturer gives a phenomenon by presenting several questions in the students' worksheet. The questions are in accordance with the learning objectives in the first step. The questions presented challenge the students to think critically. Questions are an important part of learning [4]. Questions are used to stimulate the interaction between the lecturer and the students in maintaining critical thinking. Questions with divergent categories require a variety of correct answers, open questions, and encourage students to think critically. In the prediction step, each individual works on making predictions by providing strong reasons and using scientific reasoning based on his or her initial knowledge. This is in line with Hassoubah who states that critical thinking is the ability to give a

reason in an organized way and to evaluate the quality of a reason systematically. At this stage, the students discover a new idea as a result of their prediction.

This indicates that the learning is in line with constructivist theory, that is, the new knowledge constructed by students is actively based on their previous knowledge, resulting in a process of linking the previous ideas with the new information received [18]. The existence of the students' active role in constructing knowledge, students making connections between ideas, and then sharing the results of their thoughts becomes a learning experience, that is, student-centered learning. In this learning, the focus is on the learning process, that is, "how to learn" instead of "how much is learned." This learning environment encourages students to develop their critical thinking skills. Student-centered learning can be used to develop critical thinking skills [13].

Learning becomes meaningful when students are able to relate the new knowledge with their previous knowledge. Meaningful learning involves the assimilation of new concepts and connecting them with existing cognitive structures [20]. At this step, each student focuses on the questions, analyzes the questions, and answers the questions as a result of their predictions by giving a strong reason. The reason given is in the form of a simple explanation that is connected with the previous knowledge.

The third step is the formation of groups. In *PDEODESTAD*, the formation is divided into groups consisting of 5-6 students formed heterogeneously. The group members have different characteristics, regardless of race, ethnicity, religion, gender, or academic ability. The small heterogeneous groups collaboratively prepare the students to achieve the determined competency through peer tutorial. This condition allows the students to develop their ideas without feeling embarrassed within their small groups. In this case, the students are mentally prepared to be able to develop their critical thinking skills. The group formation is a characteristic of cooperative learning. Cooperative learning is a pedagogic approach to encourage critical thinking and it is very effective to be used in the teaching and learning process [4].

The fourth step is the discussion. At this stage, there is a small group discussion. Each student shares his or her predictions of answers. They question each other, argue, and seek answers toward agreeing the group's decision. In this discussion activity, the students can develop their communication skills, questioning and answering skills, and making arguments. The students work together in building a new knowledge by forming arguments. Students experience contradiction regarding the results of their analyses compared with the results of the prediction and theories. This activity trains students' critical thinking skills. The fifth step, explanation, follows. At this stage, there is a class discussion; each small group appoints one of the group members to present their answers as a result of their small group discussion. The argumentation of each group is presented by describing their answers, using questions and answers. Individually the students are active in recording all the events in the class discussion on the students' activity sheets.

The sixth step is observation. At this stage, each student conducts an investigation to prove his or her prediction through observation. Observations are made by comparing theories from various reference sources or literature. The students make a discovery by understanding new concepts, resulting in a change of concepts. The lecturer acts as a facilitator and mediator of the discussion so that the conversation stays on the targeted concepts.

The seventh step is a discussion. At this discussion step, there is a small group discussion after observing. Each student brings together the results of predictions with observations. The contradiction between the predicted results and observations is analyzed by each student. They then do questions and answers together, analyze, compare and criticize the results of the class discussion, and seek answers, as the decision which will be presented in the class discussions.

The eighth step is an explanation. This explanation stage is a class discussion after the small group discussions, the results of analyzing the understanding of predictions through observation. Every small group appoints one of their group members to present the results of the group discussion after observation. They question and answer, and they make argumentations. The students' active activities are more apparent when each group presents their analysis based on the results of the observation, and then they make an evaluation and draw conclusions by deciding the answers that have been agreed during the class discussion. Here the students perform high-level thinking: analysis, synthesis, and evaluation. Finally, the student can solve a problem that is a contradiction between the initial concept through the predictions and the results of observation. The lecturer plays a role in monitoring the activities and leading to the conclusion that is based on scientific principles.

The discussion and explanation stage trains the students to communicate and to express ideas, answer questions, and give a conclusion. This activity ensures the students' understanding in class discussions, and that they finally can solve the problem. A person who thinks critically is one who tries to solve complex problems in a different way through questions and answers, relevant information, discovery, and communication practice [21].

The *PDEODESTAD* strategy consists of a discussion method, which is one of the effective stimuli for developing students' critical thinking skills. Discussion is an effective way to develop critical thinking skills [17]. The cooperation of group members showed a cooperative learning. The ninth step is quizzed / tests to provide feedback to determine the success of the learning process with the implementation of the strategy. The evaluation of critical thinking skills aims at diagnosing the levels of students' ability, providing feedback to students' thoughts, and motivating the students to develop their critical thinking skills [11]. The tenth and the eleventh steps, namely the scoring/assessment and rewarding, have a positive effect to create a happy atmosphere in the classroom. The students then become more motivated. Motivated students will be successful in their learning process. The reward for the quiz results also provides motivation to the students to compete responsibly to win in their group, so that each group member feels the cooperation within his or her groups. The students increasingly have the spirit to compete and always make better changes than the other students, so that they become motivated to hone their critical thinking skills.

Table 3 showed that the gain score was 0.58 in the medium category. *PDEODESTAD* can facilitate a learning atmosphere that empowers students' critical thinking skills. States that it is necessary to provide the students with a socially friendly context to bring ideas to the class, and provide the right materials, correct guidance, and ideal learning atmosphere so that their critical thinking skills can develop [11]. Finally, this research provides evidence that the implementation of the *PDEODESTAD* learning strategy can improve students' critical thinking skills.

4. CONCLUSION

The *PDEODESTAD* strategy is a combination of the *PDEODE* strategy and *STAD* strategy. The implementation of the *PDEODESTAD* learning strategy is effective for improving students' critical thinking skills on the subject of Nutrition and Health. The *PDEODESTAD* strategy is a constructivist approach strategy with cooperative learning that encourages critical thinking skills, and it is very effective to be implemented in lectures/teaching and learning process.

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