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The Effect of Blended Learning on Student's Critical Thinking Skills in Plant Tissue Culture Course

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Abstract: ***The aim of this study is to know the effect of blended learning approach on critical thinking of students in plant tissue culture course in the State University of Medan. The research method used in this study was quasi experiment. The population of this study was all semester VIII students of biology education program of the State University of Medan. The study sample consists of two classes, namely: class A known as control class who were taught by conventional learning approach and class C known as experiment class who were taught by blended learning approach. They were selected using cluster random sampling technique. The results of the study show that*** $t_{count} = 2.15 > t_{table} = 1.661$ ***at the level significance of 0.05. Based on the study result, it can be concluded that there is an effect of blended learning strategy on students' critical thinking ability. The blended learning approach is significantly more effective in enhancing student's critical thinking ability in plant tissue culture course in the State University of Medan as compared to the conventional learning approach.***

Keywords: Blended learning, Plant tissue culture, critical thinking ability, State University of Medan

1. Introduction

Teacher as a frontier in education should be able to carry out the mandate in training critical thinking for students [1]. In order to teach students how to think like a scientist, teacher himself must have a high critical thinking skills. Besides, the critical thinking skills helps teacher in teaching process, especially at discussion and debate with the students in difficult subject(s). It also helps individuals to improve their understanding of the information they find and promotes problem solving and better decision-making in real-life applications [2].

State University of Medan, as Indonesian's leading university in producing graduates of biology teachers, are expected to produces good quality teacher with high critical thinking skills. So, one of current higher education aim's, especially in State University of Medan, is to teach and develop student's (teacher candidates) critical thinking skills, as Critical thinking is a very important skills a teacher must have.

Critical thinking has been researched in many scholarly fields, including education and psychology, which has provided diverse definitions [3]. Critical thinking as reflective thinking that focuses on deciding the believed act or something done [4]. Another idea which was stated is that critical thinking is the ability to examine information by posing crucial questions, analyzing and evaluating relevant information, implementing theoretic notions, and effectively communicating with others [5].

Critical thinking enhance students ability and times to understand learning subject better and deeper, it's a crucial skills that every students must have. In this respect, critical thinking is one of the basic pillars of success in personal and academic life [5].

Plant tissue culture is compulsory courses in biology program of the State University of Medan. Based on the preliminary study conducted, it revealed that many students have learning difficulties in plant tissue culture course, this could be seen as many students pass this course with poor to average final scores. Further, researcher gives students the preliminary test of critical thinking skills, and the proof showed that test score in the scale of 0 – 100, obtained the average score is 34.1. Students have difficulties in learning plant tissue culture course in university due to lack of learning aid in understanding the course optimally [6].

Although critical thinking is highly valued, it is also difficult to teach effectively [7]. This research aims to improve students' critical thinking skills in order to solve their learning difficulties in plant tissue culture course. There are two typical approaches to teach critical thinking skills: indirect and direct approaches [8]. In indirect approaches, students are expected to develop indirect critical thinking skills by studying a variety of courses, such as literature and history. The direct approach implies teaching students in a direct manner how to think critically, such as theoretically based real life scenarios. However, neither approach effectively improved students' critical thinking skills [7]. These findings make relevant the examination of technology resources to help improve such skills. The use of current and engaging technology tools may meet the students' needs and the goals of education [8].

General technology implemented in higher education globally with fully acceess is the internet. Internet commonly

used in teaching and learning environment in higher education is known as e-learning or blended learning. Blended learning aims at combining the advantages of both face-to-face and e-learning environments [9].

Blended courses have proven to be more effective than fully online courses because it can create a positive relationship between face-to-face and online environments [10]. Thus, blended learning develops students as independent learners [11]. "blended learning is the thoughtful integration of classroom face-to-face learning experiences with online learning experiences" [12]. Nevertless, the introduction of blended learning (combination of face-to-face and online teaching and learning) initiatives is part of these innovations but its uptake, especially in the developing world faces challenges for it to be an effective innovation in teaching and learning [13].

Some studies [14 - 15] indicate the possibility of developing critical thinking through some e-learning applications. Blended learning environments able to enhance students' engagement, problem solving, and critical thinking skills [16].

In the context of the above explanations, the use of blended learning is expected to improve students' critical thinking skills in plant tissue culture courses. Drawing upon this proposition, the present study attempted to determine how blended learning affects student critical thinking skills towards plant tissue culture courses.

1.1 The aim of study

The aims of this study where to find out is there any effect of using blended learning approach on student's critical thinking skills at plant tissue culture course in State University of Medan.

2. Method

2.1 Research Procedure

In order to determine the effect of blended learning on students' critical thinking skills, pre and post-tests before and after the implementation of blended learning in the course were applied. Before the implementation, the researcher has designed a special education website to teach the basic concept of the course contents in plant tissue culture according to the regulars. The website course contents and design were revised by taking the opinion of: 2 lecturers who are experts on plant tissue culture material and language, 2 lecturers who are expert on learning media design, 2 lecturers who are expert in instructional media design, and 2 lecturers who are expert on website design. After that, the website was revised by taking the opinion of 3 students that passed plant tissue culture class. After then, it was revised by taking the opinion of 10 students that passed plant tissue culture class. Lastly, it was revised by taking the opinion of 30 students that passed plant tissue culture class. Students were informed about the practice. The critical thinking skills test prepared within the scope of the study was applied as a pretest to the students. The practice took five weeks (10 class hours). The control class studied in a class where conventional learning environment (lecture and discussion) was offered. On the other hand, the experimental class studied in a class where blended learning environment (website usage) has been provided. At the end of the practice, the critical thinking skills test was applied as a post-test to the students.

2.2 Research Design

This research work adopted a pre-test-post-test-control group design to examine the usage of website as learning media in blended learning approach against the conventional teaching approach on critical thinking skills among higher education students in Indonesia. The pre-test-posttest-control group design is a randomized experimental design which consists of experimental and control group. The study's design is as follows:

Experimental class	: Pa	X1	Pb
Control class	: Pa	X2	Pb
X1 : Blended learning approach			
X2 : Conventional teaching approach			
Pa : Critical thinking skills pretest			
Pb : Critical thinking skills posttest			

Figure 1: Research design

X1 is the blended learning approach using website media implemented to experiment class and X2 is the conventional teaching approach implemented to control class. This design was followed because both groups have been randomized as well as exposed to pre-test and post-test. Therefore, whatever happens to the experimental group, apart from the treatment, also happens to the control group.

2.3 Population and Sample

A cluster sampling technique was used in the study. This sampling technique is used in a situation where the population members are naturally grouped into a unit that can be conveniently used as clusters [17]. 94 students selected from two intact classes of Biology Program in Faculty of Mathematics and Science at the State University of Medan, Indonesia. One class of 51 students acted as the experimental class, and another class of 43 students acted as the control class. Both classes were taught by the researcher. The two class were pretested on the critical thinking test before the treatment. The results of a t-test showed that there were no statistically significant differences both on pre-test scores of critical thinking skills (t_{count} (0.65) ; P = 0.81) between the experimental and the control classes. Therefore, these results indicate that students in both the classes had similar pretest scores in critical tinking skills in plant tissue culture subject before the experiment commenced.

2.4 Data Collection Tools and Data Collection

The critical thinking test, which consists of 15 items, was developed based on the critical thinking indicator [18]. This test also covered all knowledge aspects of six plant tissue culture undergraduate learning objectives. Table 1 shows the

distribution of respective critical thinking skills instrument test based on the critical thinking indicators [18]. Table 2 shows the distribution of respective critical thinking skills instrument test based on six plant tissue culture undergraduate learning objectives.

Table 1: Distribution of critical thinking skills instrument test items based on critical thinking indicator [18].

Indicators	*Characteristics*	*Item's number*	*Total*
Elementary Clarification	Focusing on a question		
	Analyzing arguments	1	1
	Asking and answering questions of clarification and challenge	13, 8	2
Basic support	Judging the credibility of a source	2	1
	Observing and judging observation reports	12, 15	2
Inference	Deducing and judging deductions	5	1
	Inducing and judging inductions	6	1
	Making and judging value judgments	11	1
Advance Clarification	Defining terms and judging definitions.	14	1
	Identifying assumptions	3, 4	2
Strategy and Tactics	Deciding on an action	9, 7, 10	3
Total		15	15

Table 2: Distribution of Learning Achievement instrument test cognitive level

Subject Aspects	*Item's number*	*Total*
An introduction of plant tissue culture: cell theory of totipotency, it's benefits, needs and implementation.	1, 2, 3, 4	4
Plant tissue cultures medium and it's components.	7, 8, 9	3
Composing plant tissue culture medium.	5, 6	2
In vitro plant propagation: protoplast fusion and callus culture.	12, 13	2
In vitro plant propagarion : cell and callus culture.	14, 15	2
Organogenesis : apical culture, meristem culture, embryogenesis, embryo culture, and root culture.	10, 11	2
Total	15	15

All questions were presented in a multiple-choice format. Each item had five alternative choices for the correct answer. For each questions, the students gets score 1 (one) if the answer is correct and 0 (zero) if the answer is wrong. The maximum score was 100. The content and face validity of this test was confirmed and checked through revision and comments of 5 doctorate and master's degree holders and lecturers in plant tissue culture education at the State University of Medan. The test was piloted with biology students (n = 20) who had taken the plant tissue culture course the semester before. Using product moment correlation shows that 15 out of 25 items of critical thinking skill test was valid ($r_{count} > 0.44$). Using Crobach's Alpha, the reliability of test was 0.85. It was, therefore, accepted that the test was valid and had good reliability and discriminatory power.

2.5 Statistical Analysis

All statistical analyses were calculated using SPSS statistical package software.

3. Findings

Table 3: Mean and standard deviations of critical thinking skills post-test scores for two class

Class	*N*	*Mean*	*Std. Deviation*
Experimental class	51	75.29	11.01
Control Class	43	70.23	11.76

As displayed in Table 3, the students in the experimental class who taught with blended learning approach had a higher critical thinking skills post-test score ($\bar{X}$=75.29, SD=11.01) than students in the control class who were taught by conventional learning approach ($\bar{X}$=70.23, SD=11.76). In order to answer the research question number 2 which is "Is there any effect of using blended learning approach on student critical thinking skills at plant tissue culture course in State University of Medan?", we calculated the post-test score of both class by using t-test as displayed in Table 6.

Table 4: The independent sample t-test result of critical thinking skills posttest

Class	*Levene's Test for Equality of Variances*		*t-test*			
	F	*Sig.*	*t*	*Df*	*Sig (2 tailed).*	*Mean Differences*
Equal variances assumed	.475	.492	-2.15	92	.034	-5.0617
Equal variances not assumed			-2.13	87.09	.035	-5.0617

As shown in Table 7, the obtained p (0.034) is smaller than 0.05. So the test is significant at 0.05 level. This means that there is a significant difference between the two classes. This result indicates that there is an effect of using blended learning approach on student critical thinking skills at plant tissue culture course in the State University of Medan.

Table 5: Mean and independent sample t-test result among each indicators of critical thinking skills [18] between both classes in posttest

Cognitive Level	*Control Class*	*Experiment Class*	*Sig*
Elementary Clarification	69.76	82.35	0.004 **
Basic support	73.64	75.16	0.745
Inference	63.56	69.28	0.294
Advance Clarification	71.31	74.50	0.505
Strategy and Tactics	72.86	75.16	0.675
Mean	70.23	75.29	0.034 *

As shown in Table 8, there is only one critical thinking skill indicator that has a significant differences at level of 0.01, and it's the Elementary Clarification, while the others critical thinking skill indicators show no significant differences among both classes.

4. Discussions

Blended learning approach using website developed by researcher applied in the experimental class during the

research in State University of Medan has proven to contribute significantly to the scores of critical thinking skills. The ability of the blended learning apporach to improve students learning skills than the conventional teaching approach was expected. This result is in line with a lot of other study, blended learning provides learning experiences that enable the development of critical thinking skills of students through the use of technology (in online settings), and inter-personal interactions in (face-to-face settings) [8]. A research also state that when compared to the traditional instruction method, the blended learning model contributes more to critical thinking dispositions and levels of students [15]. Internet-based learning improve student's critical thinking skills [14]. Bringing together critical thinking skills and blended learning technological tools may be beneficial in that it provides an additional opportunity for interested students to achieve higher levels of knowing and to practice critical thinking skills [19].

Students in higher education as adult human has developed it's own nature to learn independently and socially, the environment creted by blended learning approach trigger students to construct their knowledge and improve critical thinking skills collaboratively and independently. Blended learning provides an extra time for students to be able processing some new information deeply. As one of critical thinking indicator is analyzing arguments and clarifying, time and independent thinking is needed to be succesfully develop students critical thinking skills. Rovai [20] (2004) state that the extra time to process information provided by blended learning allowed students to give more in-depth answers and promoted critical thinking skills. Students process the information better when it is presented online, because they have to analyze it by themself before they hear someone else's interpretation of what they learn. By forcing students to be independent and have control over their learning, blended formats can help foster critical thinking and facilitate collaborative learning [21]. It also gives the internal thinking style by giving great tools for students who prefer to learn by him self.

Blended learning provides multimedia learning such as videos, animations, pictures, games, and flash. In this research, researcher trying to creates a well designed blended learning website, that provides plant tissue culture problem solving online project in it that can't be applied in conventional learning. This project requires students deep and critical thinking in order to solves it, through the availability of online project, students are required to actively carry out their critical thinking skills such as judging the credibility of a source, observing and judging observation reports, deducing and judging deductions, inducing and judging inductions, making and judging value judgments, defining terms and judging definitions, identifying assumptions and deciding on an action.

Lecturers doesn't required to watch students directly when blended learning approach implemented, since higher education students is not same as school students which is need an extra support and guidance from their teachers to succesfully develop the critical thinking skills using blended learning approach. However, lecturers need to develop their ability to develop and design the blended learning well in order to achieve the learning aim and critical thinking skills of students. Lecturers also need to effectively facilitate students' learning processes and support social interaction. lecturers should keep a watchful eye on the forums and chat [8].

5. Conclusion

Based on the results of this research and the discussion, it can be summarized that there is an effect of using blended learning approach on student critical thinking skills. It can be concluded that the blended learning approach is significantly more effective in enhancing student's critical thinking skills in plant tissue culture course in State University of Medan when compared with conventional learning approach.

The success of blended learning approach in improving students' critical thinking relies on many factors, such as student's learning motivation, style, dicipline, blended learning website, facility, learning aids, lecturers teaching skills, learning environment, students' abilities to use technology in academic settings, and most important, lectures ability to design blended learning approach. Therefore, researcher suggest for lecturers who want to use blended learning as learning strategy in higher education, especially on plant tissue culture course, to study and understands the student's character, learning ability and learning style on that course, than design the blended learning approach based on these student's criteria.

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