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Promoting undergraduate students' critical thinking skills in zoology vertebrate courses

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ABSTRACT: The goal of science education is to develop critical thinking skills. Critical thinking skill is important in education as well as in everyday life. In this study to promote students' critical thinking skills we used a team-based learning instructional model. The purpose of this study was to evaluate the potential effects of a Team-Based Learning (TBL) instructional model on undergraduate students' critical thinking skills. A quasi-experimental pre-test/post-test with control group design was used to determine critical thinking gains in a TBL and a non-TBL group. The instrument to collect data was open-ended questions that represented by critical thinking elements. The result showed that TBL can improve undergraduate students' critical thinking skills and also showed that the TBL group had significantly quantitative differences compared to the non-team-based learning group in improving students' critical thinking skills. Through the results of this study, it is hoped that the faculties who value both research and critical thinking will consider using the TBL instructional model.

1 INTRODUCTION

21st-century competencies that must be possessed by students are critical thinking and problem-solving skill (Trilling & Fadel 2009; Ledward & Hirata, 2010). This is also in line with the goal of science education, namely to develop critical thinking skills (Bailin, 2002), which means avoiding memorizing terms, but instead building relationships between concepts, applying the appropriate framework for solving the problem, and drawing conclusions critically (Bransford et al., 2000). The importance of critical thinking has been proven since the time of Socrates (Quitadamo et al., 2008). Critical thinking skills are regarded as one of the essential skills that directly influence academic and professional success (Bassham et al., 2010).

Critical thinking skills have a strategic role in the field of education. Many college faculties consider critical thinking to be one of the most important indicators of student learning quality (Quitadamo & Kurtz, 2007). This is in line with the demands of the working world that higher education stakeholders seek individuals who are able to think critically and communicate effectively are to join their company (Benjamin et al., 2013). Therefore, higher education faculties need to make practical instructional changes, in order for students to better compete on the international stage (Quitadamo et al., 2008). The learning paradigm in higher education should change from conventional learning that emphasizes the low-level thinking skills towards learning that emphasizes learning higher-order thinking skills or where less emphasis is placed on content-specific knowledge and more is placed on critical thinking skills, such as analytic and quantitative reasoning, and problem-solving (Benjamin et al. 2013). According to the AAAS (1989) and NRC (1996), science is learned and taught as is done in real life. Rutherford and Ahlgren (1990) state that the education of science should help students develop an understanding and habits of thought to face their future life. Learning that is not an emphasis on the development of higher level thinking skills (critical thinking skills) tends to condition students into rote learning. Students very easily forget previously learned material. Bassham et al. (2011) reported that the learning of most schools tends to emphasize lower-level thinking skills. Therefore, the purpose of this study was to improve students' critical thinking skills through the team-based learning strategy.

2 LITERATURE REVIEW

Critical thinking is a general term given to a variety of cognitive skills or cognitive activity and intellectual dispositions associated with the use of the mind (Cotrell, 2005; Basham et al., 2011). Various

definitions of critical thinking have been offered by the researchers. Norris and Ennis (1989) give the definition of critical thinking as to think reasonably and reflectively with emphasis on making decisions about what to believe or do. Inch et al. (2006) state that critical thinking is a process in which a person tries to answer rational questions that cannot easily be answered and where no relevant information is available. Critical thinking requires consideration. Halpern (2014) states that critical thinking is the use of cognitive skills or strategies that increase the likelihood of desired results. It is used to describe the thinking as being purposeful, reasoned, and goal-directed.

Cotrell (2005) suggested that good critical thinking skills bring many benefits such as increased attention and observation, more focused reading, improved the ability to identify important and less important, and analysis skills that can be applied in different situations. Basham et al. (2011) suggested that the benefits of students' critical thinking are that students can understand, critically evaluate, and build arguments. Further, Basham et al. (2011) state that critical thinking is beneficial to the world of work and in everyday life. For example, critical thinking skills can help in making decisions carefully, clearly and logically, so as to reduce the possibility of making a fatal mistake when making decisions.

Critical thinking skills are supposed to be part of the curriculum in schools. Students must be given meaningful experiences for learning in order to develop their critical thinking skills. Thus, teachers as educators are obliged to condition the learning so that students are able to develop intelligence and critical thinking skills. To meet the expectations of the above, it is necessary to develop a learning program that allows students the opportunity to practice using critical thinking skills, because critical thinking skills is an ability that can be learned (Halpern, 2014).

One of the strategies that are expected to improve critical thinking skills is Team-Based Learning (TBL). TBL is a pedagogical strategy that uses groups of students working together in teams to learn course material. The main learning objective in TBL is to provide students the opportunity to practice course concepts during class time (Clair & Cihara, 2012).TBL is one form of collaborative learning which consists of three phases: (1) During the first phase, learners read and study material independently outside class. (2) Learners complete an Individual Readiness Assurance Test (IRAT), After the IRAT, pre-assigned teams of 5–7 learners re-take the same test (Group Readiness Assurance Test (GRAT)). (3) Application and integration of information that has been obtained in phases 1 & 2 (Michaelsen & Sweet, 2008).

3 RESEARCH METHODS

The study took place at a Program Studi Pendidikan Biologi, UIN SGD, Bandung. All participants were undergraduate students on a zoology vertebrate course. The participants consisted of two classes – the control and experimental class. The research was quasi-experiment research with randomized pre-test/post-test control group design (Fraenkel & Wallen, 1990). The instrument to collect data was open-ended questions that were representative by critical thinking skill elements (Noris & Ennis, 1989). A feasibility instrument test had been tested with reliability 0.8 and was categorized as high (Arikunto, 2005). Analysis of the differences critical thinking skill enhancement was conducted with parametric statistical tests by using t-tests on N-gain critical thinking skill, which have previously been tested for normality and the homogeneity of F distribution.

4 RESULTS AND DISCUSSION

Comparison of the critical thinking skill between experiment classes and control classes as a whole can be seen in Table 1. Based on Table 1, the means of experiment class pre-test, post-test and N-gain are higher than the control class, and statistically using t-test showed that for TBL there were significantly quantitative differences compared to the non-TBL group (sig. 0.00, $\alpha = 0.05$). So, it can be concluded that a TBL strategy can promote critical thinking skill more significantly than can a traditional strategy.

Comparison of the percentage of category N-gain critical thinking skills of students between the experimental and control classes is shown in Figure 1.

Based on Figure 1, the percentage of high category in the experimental class was more than the control class. Enhancement of critical thinking skill for each indicator/element can be seen in Table 2.

Based on Table 2, undergraduate students' critical thinking skills improved in all indicators of critical thinking skill. Students in class experiments had higher critical thinking skill enhancement than

Table 1. Recapitulation of the pre-test, post-test, and N-gain critical thinking.

Sample	Mean Pre-Test	Mean Post-Test	Mean N-Gain <g>
Experiment Group	41	80	0.7
Control Group	42	67	0.4

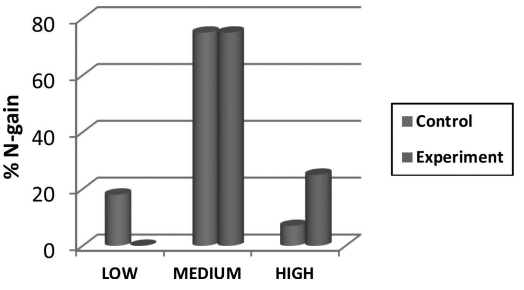

Figure 1. Comparison of the percentage of category N-gain critical thinking skills of students between the experimental and control classes.

Table 2. Enhancement of critical thinking skill for each indicator.

Indicator critical thinking skill	Pre-Test	Post-Test	N-Gain	Category
Decide on an action.	53	81	0.6	Medium
Suggests an attitude orally or in writing.	59	89	0.7	Medium
Making the induction and consider induction.	46	79	0.6	Medium
Analyzing argument.	33	79	0.7	Medium
Ask and answer questions.	25	74	0.7	Medium
Consider the credibility of the sources.	21	70	0.6	Medium
Focusing questions.	38	81	0.7	Medium
Identifying assumptions.	33	59	0.4	Medium
Identifying similarities and differences.	46	87	0.8	High

the control class. This may be influenced by the students themselves and the learning processes factor. The factor of the student had a very large impact on student learning outcomes; students with high motivation and attention will be able to achieve optimal learning (Makmun, 2008; Sudjana, 2009).

We found that TBL was an effective teaching strategy that focused on students' practice in applying concepts in class. By assessing students on both individual work and team work, students were motivated to come to class and engage in the group activities. The students were motivated to prepare for class every day, because they did not want to let their teammates down. Students learned good habits such as reading the material before coming to class. Generally, students enjoyed the TBL strategy for a variety of reasons, such as it not being boring, it was fun, and they gained a better understanding of learning materials, but this learning process requires thorough preparation and good time management.

Previous studies have shown that the use of a variety of learning strategies can improve students' critical thinking skills (Addy & Stevenson, 2014; Carson, 2015; Caruso et al. 2016; Aebli & Hutchison, 2016).

5 CONCLUSIONS

Based on the results and discussion, it can be concluded that the TBL strategy may increase undergraduate students' critical thinking skills. The results also indicated that the TBL strategy significantly facilitated critical thinking skill enhancement compared to a non-TBL strategy. Through the results of this study, it is hoped that faculties who value both research and critical thinking will consider using the TBL strategy.

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