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Enhancing Critical Thinking Skills in Biology Subject with the Legendary Model of Cooperative Learning

Ibrahim[1*], Marwan[2], Juli Firmansyah[3]

[1] Program Studi Pendidikan Biologi, Universitas Serambi Mekkah, Banda Aceh, Aceh, Indonesia.
[2] Program Studi Pendidikan Ekonomi, Universitas Almuslim, Bireuen, Aceh, Indonesia.
[3] Program Studi Pendidikan Fisika, Universitas Serambi Mekkah, Banda Aceh, Aceh, Indonesia.

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Corresponding Author:
Ibrahim
ibrahimsufi@serambimekkah.ac.id

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Abstract: This study aims to determine students' critical thinking skills by implementing jigsaw cooperative learning compared to conventional learning in the concept of environmental pollution in Aceh Senior High School, Indonesia. The method used was an experimental method with a pre-test-posttest control design. It used two classes, class X-1 as the experimental class with 20 students and X-2 as the control class with 20 students. The instrument used was a test of Critical Thinking Skills on the concept of environmental pollution. The data of student test results were processed using the independent sample t-test with SPSS version 18.0 at a significant level of 0.05. The analysis results show differences in students thinking abilities, indicated by $t_{count} > t_{table}$, which is 6.633> 2.68 for students critical thinking. There were differences in students' critical-thinking skills between those using the jigsaw cooperative model and students using conventional learning in learning the concept of environmental pollution at the senior high school in Aceh Province, Indonesia.

Keywords: Cooperative model; Critical thinking skills; Environmental pollution; Jigsaw

Introduction

The cooperative learning model combines active teaching and active learning processes that involve several small groups and is interactive to improve student learning behavior (Gleason et al., 2011). The learning carried out by the teacher has two foundations: the students' intellect and the intervention from each group member to build an effective, responsible learning team. Each student engages in the concept of real and sustainable collaboration, and during teaching activities, students are directly involved in teacher control (Amiruddin et al., 2018). Generally, the preparation of cooperative learning tasks involves all participants getting the same information while learning and completing the assignments in their groups. Each student in the group is responsible for completing certain parts and can teach other students to understand aspects of knowledge and skills (Malik et al., 2020). The most appropriate approach is to explore students' memory and understanding, which is also suitable for gaining competence, communication skills, independent thinking, and collaboration in group assignments (Darling-Hammond et al., 2020). Other scholars, Azmin (2015), state that learning is a process that changes a student's behaviors, thinking, acting, and doing. Meanwhile, teaching and learning activities aim to create an environmental system supporting the optimal learning process (Serafin, 2016).

In Biology teaching, Content Environmental pollution material is found easily in everyday life. However, the learning process tends to memorize only. It becomes an obstacle for students to understand biology subject matter. Biology is always associated with the process of discovery, which usually begins with studying and understanding the universe (A'yun et al., 2020; Lismaya, 2020). Biology learning in the 21st century requires realizing abilities, especially critical thinking skills. Skilled at solving problems, and being able to apply complex thinking models with intellectual standards are the hallmarks of critical thinking skills (Fisher, 2013).

Observation data on biology teaching materials for Senior High School class X semester 2 contain many

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concepts and performance processes to be understood. It requires scientific work skills from all students (Huang et al., 2010). For example, the concepts of environmental pollution studied by grade X students involve systematic work scientifically. Despite memorizing these concepts, students find the benefits of learning about environmental pollution to be more meaningful in life. On another side, through conventional learning in biology lessons, student learning outcomes had a relatively low average score in the final semester exams. The average semester test scores on the concept of environmental pollution in the last three years are as follows: (1) 2015/2016 = 65.20; (2) 2016/2017 = 66.79; and (3) 2017/2018 = 66.87 (Gonzalez-Casanova et al., 2018). The low achievement of student Biology learning outcomes is due to the unsuitable approaches by teachers. Teaching is only considered as a professional obligation so it has no impact on improving students' critical thinking skills.

The cooperative learning method allows students to work together and support each other in the learning process through small groups to master certain teaching materials (Tiantong et al., 2013). Jigsaw learning is a cooperative method developed by several education experts to help students learn the subject matter, directing students to teach other students holistically (Gull et al., 2015). Jigsaw learning provides an opportunity for students to understand a part of the learning material and can provide explanations to other students in their group as experts (Sugianti, 2016).

Cooperative learning, in addition to the principle of interdependence requires good skills for each student so that it is easy to carry out the teaching process in class (Tran et al., 2016). The principle concept of positive interdependence is that students work together in cooperative learning situations to achieve collective learning goals (Laal, 2013). Positive interdependence can be facilitated by giving students their respective roles in the group. This concept makes students responsible for separating information on the subject materials, but they integrate it into a complex learning interaction (Ong et al., 2020).

Given Doder et al. (2014), self-confidence and individual responsibility mean that students can work well, are skilled in presenting ideas, do proper report assignments, help groups in work, and are always collaborative with group members. The element of students' self-confidence can improve by maintaining a small number of group members (Sun et al., 2017). Members tend to communicate more intensely in small groups.

The third part is process skills (promotive interaction). The interaction or process skills will occur when students try to provide information/data to other group members. As part of the habit of cooperative learning, students get the opportunity to interact in groups or between study groups. Students can explain an idea or a reason to a friend or teach another group regarding their studied concepts. Thus, this process skill is essential to make students able to convey information, discuss in their groups, and develop learning skills and learning achievement (Changwong et al., 2018).

The final element in cooperative learning is classroom processing or class management. Good classroom management helps increase the effectiveness of members in collective efforts to achieve group goals in learning (Gillies, 2016). Evaluating the interactions between group members, examining group assignments, providing feedback, and complimenting small group presentations and the whole class is considerably practical ways to encourage group achievement. In addition, it can build satisfaction, commitment to group goals, and responsibility for work achievements. Cooperative learning results in a positive social relationship between students and teachers and expands friendships among students (Altun, 2015). It can encourage students to work together to improve achievement and knowledge; cooperative-based learning enhances positive relationships between students and develops member motivation, cohesiveness, and individual skills (Tran et al., 2016). Jigsaw instruction, designed by the teacher through small heterogeneous groups, will be more advantageous for students to understand the subject matter (Ibrahim et al., 2020).

According to Karacop (2017), students' critical thinking ability is innate. The more often students face problems that require thinking skills, the more developed and increased their ability to remember. Even without formal education, thinking ability will increase if one often faces various problems that one must go through, feel, and think about (Kimbell, 2011). States that there are several variables of thinking ability (Almulla, 2018). High school students need the skills to formulate problems, provide arguments, verbalize, conduct evaluations, and conclude in a limited time provided through jigsaw-type cooperative learning and it can strengthen students' understanding of concepts on the other hand (Darling-Hammond et al., 2020).

The jigsaw technique is designed to enhance cooperation and team solidarity among students by dividing into home groups and expert groups (Aronson et al., 1979; Engül et al., 2014; S. Sharan, 1980). Figure 1 illustrates the jigsaw cooperative learning model. Expert groups consist of members from different groups of origin and gather to study and discuss the same subject. Students return to their home groups and share the information they have learned with their home group members (Doymus, 2008).

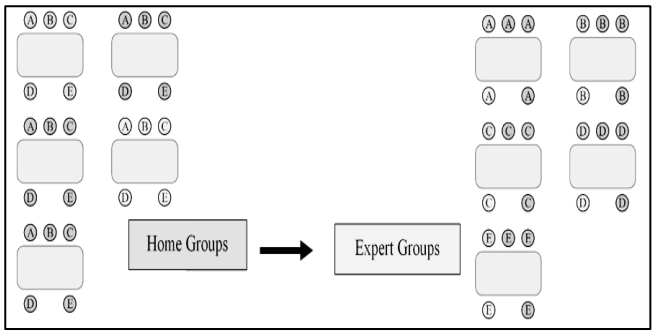

Figure 1. Home groups and expert groups

The jigsaw type of cooperative learning provides space for critical thinking and analysis skills to solve problems in students' life, affecting their way of thinking (Saputra et al., 2019). In line with the former opinion, Jigsaw cooperative learning leads to critical thinking skills and can motivate students to investigate problem-solving (Adams, 2013). Jigsaw cooperative learning can stimulate trust and thinking in seeking information, empower students to be responsible, and improve academic achievement (Y. Sharan, 2014). This study aims to determine students' critical thinking skills by implementing jigsaw cooperative learning compared to conventional knowledge in learning the concept of environmental pollution in Aceh Senior High School, Indonesia.

Method

Experimental research was applied involving pretest-posttest and randomized control groups. The subjects were students of class X in a public senior high school in Aceh Province, Indonesia. The school was selected purposefully based on four criteria: (1) stability of facilities and laboratories, (2) school status (public), (3) male and female students are unified (4) complete facilities and teachers. The experimental class was taught with the Jigsaw approach, and the control group with conventional teaching. Data collection was through a critical thinking test (using multiple choices) compiled based on environmental pollution teaching materials with as many as 40 test items. Four indicators regarding students' critical-thinking skills are involved in the pretest and posttest. Indicators of critical thinking skills consist of the ability to analyze, conclude, evaluate, and make decisions (Changwong et al., 2018).

The research sample involved 20 students in the experimental and 20 students in the control classes. The experimental class applies Jigsaw cooperative learning, and the control class applies conventional learning. The increase in critical thinking skills of the two classes, before and after the learning was carried out, was calculated using the normalized gain formula <g> (Hake, 1999) with the high category (score g> 0.7), moderate ($0.3 \leq g \geq 0.7$) and low (g <0.3).

Result and Discussion

The research results were obtained from the pretest (initial test) and posttest (final test) scores. The data, as shown in table 1 below, is the pretest result data from the experimental class and the control class after environmental pollution learning.

Table 1. Average Pretest Values of Students

Class	Average	Normality	Homogeneity	Sig
Exp.	46.00	Sig 0.38 > 0.05		$t_{count} < t_{table}$ 0.09 < 2.68
			Sig 0.70 > 0.05	Sig (2-tailed) 0.93
Control	45.75	Sig 0.07 > 0.05		> 0.05 no different Real

The results of the pretest of the two classes showed no difference between the two classes, meaning that before learning was applied, the two classes had no differences. Table 2 presents the ability of the student posttest experimental and control class.

Table. 2. Average Posttest Value of Students

Class	Average	Normality	Homogeneity	Sig.
Exp.	75.225	Sig 0.052>0.05		$t_{count}>t_{table}$ 6.633> 2.68
			Sig 0.643 > 0.05	Sig (2-tailed) 0.00
Control	68.125	Sig 0.098>0.05		<0.05 Difference in Real

Table 3. N-Gain for Critical Thinking of Students

Class	Average	Normality	Homogeneity	Sig.
Exp.	65.70	Sig 0.157>0.05	Sig 0.072> 0.05	$t_{count} > t_{table}$ 2.965> 2.68 Sig (2-tailed) 0.000 <0.05 Different Real
Control	59.15	Sig 0.259> 0.05		

The average value of the N-gain of the experimental and control class is shown in Table 3. Table 3 shows the

N-Gain average using the t-test. These results indicate that the data is significant.

Discussions

The data in Table 1 that implies that the abilities of these two classes are still low. Then it shows the distributed data is normal.

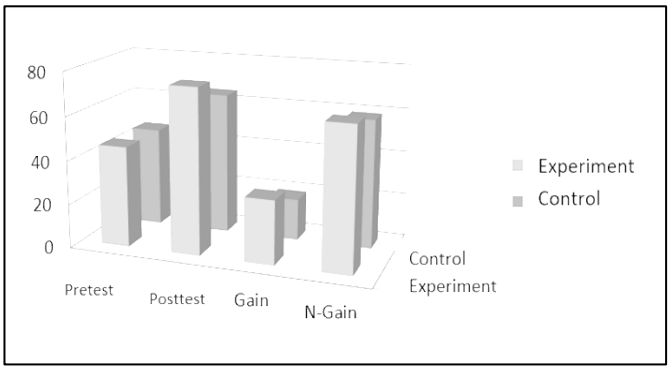

Figure 2. N-Gain scores

The homogeneity test was also carried out using SPSS 20.0, and the result was Sig .702> 0.05, which means that the data of the two classes were declared homogeneous. This shows that the initial abilities of the subjects in the experimental class and the control class were the same, meaning that there was no significant difference between the experimental class pretest and the control class pretest.

In Table 2, it is followed by the Independent Samples Test t-count, 6.633> 2.68. This shows that there are significant differences in the abilities of students in the experimental and control classes.

The hypothesis testing results show a difference in critical thinking between students taught by applying the jigsaw-cooperative model compared to those who learn conventionally. The data obtained were significantly different. It can explain that the jigsaw cooperative learning model has higher critical thinking values than conventional learning. In line with the previous research that the process of learning activities can improve by learning using the jigsaw learning model and students actively learning (Suendarti, 2017). So, it takes innovation from teacher to students to make students able to think in learning activities.

The results showed that the student's ability to answer questions before learning using the jigsaw learning model was still low. The initial research proved that most students could not answer questions well. Some of the information was obtained before the implementation of the research. The control class, namely the low category, consists of three students, the moderate class consists of nine students, and the high category comprises seven students. From the experimental class, the low category consisted of one student, the moderate consisted of 11 students, and the high category was eight students. It can be concluded that there are differences in the critical thinking results of students with the use of the jigsaw cooperative learning model (Şengül et al., 2014).

The success of the Jigsaw learning model which can be considered a legend, in improving student learning outcomes including students' critical thinking skills is in accordance with the results of previous research. The results of the research put forward by Kiuk (2021), state that the application of lesson study with the jigsaw model has an impact on student activity in class including improving their skills while studying. Furthermore, Alfaruqy (2021) found that student motivation and achievement can increase significantly after using the jigsaw technique and giving appropriate rewards. The Jigsaw Learning Model is appropriate for science subjects and can improve students' critical thinking skills (Wiwin et al., 2020).

Conclusion

Based on the results of the research conducted, it can be concluded that there are differences in students' critical thinking abilities through the application of the jigsaw legend cooperative learning model. These findings provide more empirical knowledge for Indonesian Biology teachers to make teaching changes to improve student's critical thinking, social attitudes, and character. Another note is that cooperative teaching and learning increase social interaction, mental attitude, and students' confidence in presenting and maintaining new ideas, which are helpful in their lives. Researchers expect that there will be further studies using the Jigsaw strategy so that students 'critical thinking is followed by students' social attitudes that help students live in society.

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Author Contributions

The contribution of the authors is equal. IB conducted a literature review, conducted fieldwork, and developed an outline for writing the article. MR wrote the research methodology and performed data entry and processing. JF performed statistical analysis and interpretation of results.

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Conflicts of Interest

The authors declare that there is no conflict of interest.

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