Implementation of the Jigsaw Model to Improve Critical-Thinking Skills

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Critical thinking skills require an active learning process that involves deciding whether to agree or disagree with the information, making judgments to ensure correctness, and correcting inaccurate information to generate new ideas. This study employed Classroom Action Research (CAR) with the main objective of identifying learning models that can increase student involvement in learning mathematics and improve students' critical thinking skills. This study aims to improve students' critical thinking skills using the Jigsaw cooperative learning model. The teacher conducting the study used the applied learning model, while the researcher acted as an observer. This activity involved twenty-five tenth-grade and was conducted at Madrasah Aliyah Al Muayyad Surakarta. The results showed that by implementing the Jigsaw cooperative learning model, there was an increase in the process of learning mathematics in both cycles. The results showed the jigsaw learning model could improve students' critical thinking skills with an average increase of 43% in critical thinking skills before the study.

Keywords: classroom action research, critical thinking skill, jigsaw, mathematics teaching

INTRODUCTION

Critical thinking skills need to be continuously developed in the student since critical thinking is a fundamental skill, they must have in the 21st century (Lai, 2011). One of the main reasons for this is that thinking critically is required to participate in higher education and obtain degrees (Boholano, 2017). Moreover, the ability to think critically is considered the most widely utilized intellectual skill in decision-making within society (Mulnix, 2012). According to Culver, Braxton, & Pascarella (2019), when someone thinks critically, they can develop self-motivated knowledge in modern society. Good critical thinking skills can also help someone to be cognitively competent to achieve goals (Heersmink, 2018). Consequently, the development of critical thinking skills has become a top priority in modern education. Therefore, every individual must develop this skill to make sound decisions that will help them navigate life challenges.

One of the methods used to develop students' critical thinking skills is through optimised mathematics learning (Umar, 2017), which is also the main objective of the worldwide mathematics curriculum to aide in the development of critical thinking skills (Kadir, 2017). Uzel & Uyangor (2006) argues that students' critical thinking skills must be developed to help them solve their problems. The claim was based on the universality of mathematics as a science that underlies the development of modern technology (Hasibuan & Silvya, 2019) and plays an essential role in various other disciplines (Yadgarovna & Husenovich, 2020). Mathematics, known as a structured, systematic scientific activity that develops critical, objective, and open-thinking attitudes, becomes very important for students to master in the face of an ever-evolving field of science and technology. . Therefore, mathematics and critical thinking must be integrated to create a meaningful and successful learning activity. Mathematics is, however, often taught formally with normative and dogmatic principles (Li & Schoenfeld, 2019). It helps lessen the notion that mathematics becomes meaningless since students cannot fully understand and implement mathematical knowledge in solving problems in everyday life.

In the traditional learning paradigm, the learning process usually takes a teacher-centered approach where the teacher instructs and creates scheduled lessons. Also, teaching and learning occur only at a predetermined time and place (Wanner & Palmer, 2015). The teacher is responsible for the effectiveness of teaching and learning in the classroom since the teacher plays a dominant source of learning. However, this can cause students to become overly dependent on the teacher and become less active and creative (Hou, 2015).

Many studies related to the critical thinking skills of high school students have been conducted and have revealed many problems exist with students' development of these skills (Basri, Purwanto, As'ari, & Sisworo, 2019; Fitriani, Zubaidah, & Hidayati, 2022; Hidayati & Sinaga, 2019; Mahanal, Tendrita, Ramadhan, Ismirawati, & Zubaidah, 2019; Mulyanto, Gunarhadi, & Indriayu, 2018). Ennis (1996) identified twelve critical thinking skills into twelve indicators and grouped them into five activities, namely: (1) elementary clarification; (2) basic support; (3) inference; (4) advanced clarification; and (5) strategy and tactics. Critical thinking skills are learning outcomes categorized as one of the high-order functioning (Elder & Paul, 2020; Fitzpatrick & Schulz, 2015), closely related to the cognitive activity (Fisher, 2001). Activities that involve opinions, judgments, observations, and communication are part of critical thinking activities (Fisher, 2001). Analysis and evaluation are other ways of defining critical thinking (Cottrell, 2005). Critical thinking skills can also be characterized as accurately assessing a reason or discovering a false belief (Epstein, 2006; Mason, 2008).

We can describe critical thinking skills as an active learning process that involves deciding whether to agree or disagree with the information, making judgments to ensure correctness, and correcting inaccurate information to generate new ideas (Florea & Hurjui, 2015). The metacognitive process, which includes the ability to analyze, synthesize, evaluate, and encapsulate ideas or solutions effectively to solve a problem, is a component of many skills that make up the process of critical thinking (Dwyer, Hogan, & Stewart, 2014). As a result of learning in the cognitive aspect, critical thinking skills can be measured using test questions. Critical thinking test instruments can be developed based on Bloom's Taxonomy indicators which include memory recall, understanding, applying, analyzing, synthesizing, and evaluating (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956) which was later revised by Anderson & Krathwohl (2001) to remember,

understand, apply, analyze, evaluate, and create. The levels in Bloom's Taxonomy are categorized into two categories (Magas, Gruppen, Barrett, Dedhia, & Sandhu, 2017), namely Low Order Thinking Skills (LOTS) which include remembering, understanding, and applying, and High Order Thinking Skills (HOTS) including analyzing, evaluating, and creating). Therefore, critical thinking skills can be measured through three indicators: analyzing, evaluating, and creating (Dwyer et al., 2014).

Critical thinking skills can be developed through discussion during the learning process in class (Schoenberger-Orgad & Spiller, 2014), and one of the factors that influence the process of developing students' critical thinking skills is the teaching style (Nuraida, 2019). Therefore, finding appropriate and effective learning models for teaching mathematics is essential to improve student's critical thinking skills. Discussions in learning can be formed by implementing cooperative learning. Cooperative learning is an educational strategy that can encourage students to be actively involved in teaching and learning activities (Chatila & Husseiny, 2016). Cooperative learning is an educational strategy that can encourage students to be actively involved in teaching and learning activities (Casey & Goodyear, 2015). According to Maonde et al. (2015), cooperative learning helps students and teachers navigate their academic endeavors more effectively, for example, students who were previously passive learners begin to engage in problem-solving exercises. The jigsaw cooperative learning paradigm is one learning model that teachers can use to create effective learning. The research results of Amin, Nur, Diah, Damayanti, & Harti (2020) concluded that by applying the jigsaw-type cooperative learning model, students tend to better understand mathematics, which motivates them to learn mathematics effectively. The claim is supported by Guntur, Anggraini & Rosnawati (2020), which state that cooperative learning, especially jigsaw, nets positive results on students' attitudes toward learning. Students tend to understand the material better, become more independent in learning, gain self-confidence, and are more comfortable expressing their ideas when sharing their knowledge with their group mates.

The jigsaw cooperative learning model is a learning model that focuses on student group work in the form of small groups. Suendarti (2017) describes that jigsaw cooperative learning technique where students have greater responsibility in implementing effective learning. The jigsaw model developed by Slavin (1985) emphasizes activity and interaction between students to motivate and help each other in mastering the subject matter to achieve maximum performance. The hallmark of jigsaw cooperative learning is the existence of a group of experts. Cooper (2013) explained that jigsaw is designed to make students work together as they are divided and participate in expert groups and core groups. In expert groups, students collect information about one aspect being studied which helps them become experts in the discussion. Then, they gather in their respective core groups and share the expertise they gained from the expert group so that each student in the core group has become an expert in a different aspect.

The results of initial observations in one of the Madrasah Aliyah (Islamic Boarding Schools) in Surakarta, Indonesia, indicate that teachers experience difficulties in determining the right learning model for their students. In mathematics teaching, teachers often act as students' center of attention and knowledge, even though various innovations have been developed to create more engaging and fun mathematics learning experience. (Darma, Karma, & Santiana, 2020). This study, therefore, aims to introduce teachers to a learning model (jigsaw) that can be implemented in class and, at the same time, to see whether the jigsaw learning model can be used to improve student's critical thinking skills. Previous researchers have conducted several experiments using the jigsaw learning model, showing that the jigsaw cooperative learning paradigm improves student achievement and understanding (Doymus, 2008; Tran & Lewis, 2012). The jigsaw learning model has been used in previous research but only to assess learning achievement and the student's understanding of the material without involving critical thinking skills.

RESEARCH METHODOLOGY

This research is a Classroom Action Research (CAR) with the main objective of identifying learning models that can increase student involvement in learning mathematics in general and improve students' critical thinking skills. CAR is part of action research, according to Suhardjono (2010, p. 57), "Based on

the objectives of action research, CAR is one part of action research with specific objectives related to the class." Suharsimi (2008, p. 2) describes a research activity carried out in class.

This research was conducted with the teacher who used the applied learning model, while the researcher acted as an observer. This activity involved twenty-five tenth grade students and was conducted at *Madrasah Aliyah Al Muayyad* Surakarta. Research activities are based on a predetermined action plan, learning which has been carried out following the Learning Implementation Plan (RPP). The main focus of the methodology used in this study is the jigsaw model, which is optimized to improve students' critical thinking skills.

The data analysis technique used is a quantitative analysis and uses descriptive statistics. The data is collected through a test that contains a series of questions. The tests given were adjusted to indicators of critical thinking skills and adapted to the material being studied by students. Students' critical thinking skills formed through applying the jigsaw learning model can be considered complete if they meet the criteria. The following formula is used to calculate the percentage of students' critical thinking skills.

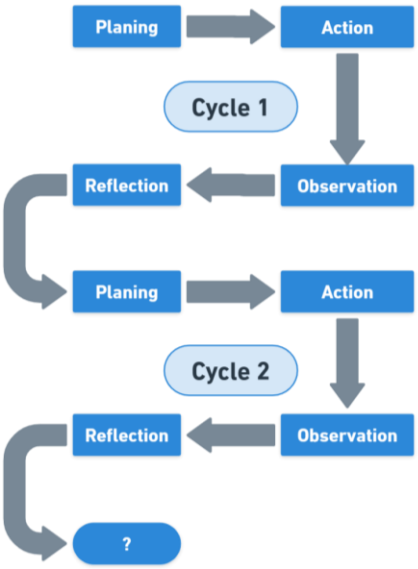
$$K = \frac{\sum k_m}{m.n} \times 100\%$$

Description:

K = percentage of indicators of achievement of critical thinking skills
$\sum k_m$ = the total score of all students achieved on critical thinking skills questions
m = maximum score multiplier
n = number of students (25)

The CAR was divided into two cycles, consisting of two meetings. This research was conducted through four stages: planning, action, observation, and reflection. The flowchart used in this study can be described in Figure 1.

FIGURE 1
THE FLOWCHART OF CAR



RESULTS AND DISCUSSION

The implementation of learning with the jigsaw model at the stages of cycles 1 and 2 shows an increase in students' critical thinking skills according to the indicators used.

TABLE 1
REPRESENTS THE PERCENTAGE OF STUDENTS' CRITICAL THINKING SKILLS BEFORE ACTION, AFTER CYCLE 1, AND AFTER CYCLE 2

Aspects	Before Action	After Action	
		Cycle 1	Cycle 2
Analyzing	44%	68%	88%
Evaluating	40%	56%	84%
Creating	32%	48%	72%

Cycle 1

Cycle 1 was carried out in one meeting of three forty-five-minute sessions discussing basic competence 3.3 with the title of "composing a system of three-variable linear equations from contextual problems." The researcher and the teacher designed learning tools and test instruments in the planning stage. The next stage is the implementation stage. Cycle 1 action includes preliminary activities, core activities, and closing activities. During the learning process, the researcher, as an observer, records the results of observations on the observation sheet, which is then used as material for reflection.

In the introduction (45 minutes), learning begins with an introduction by the teacher regarding the general description of the material. Previously, the teacher prepared different problems according to the number of groups in the student worksheet. Then the teacher instructs students to form groups. The teacher's method of forming groups was by asking students to count from one to five repeatedly. All five groups were formed, consisting of five students with numbers one to five; this group was called the "home" group or jigsaw group. Students were asked to remember the members of each core group because next, the teacher forms a new group, a collection of students with the same number, referred to as the expert group.

In the core activity (60 minutes), each group of experts gathered to discuss the problem according to their part. The group leader ensured that all members understood the problem-solving steps discussed in the expert group. After the groups have finished working on the questions, each member split up to gather in the home group. Students then presented their findings one by one.

Toward the end (30 minutes), students were given questions and worked individually to measure the students' critical thinking skills that had been validated. The teacher concluded the lesson by providing conclusions related to the material being studied.

The researcher identified the successes and failures that emerged in the implementation of cycle 1. The success is optimal time management as a result of implementing the jigsaw learning model. As for the failures, the expert groups did not take into account students' academic abilities, the randomly formed groups, the inactivity of students during home group sessions (where each student only listened to other students presenting), and the absence of any criticism or observations made by fellow students. However, the implementation of cycle 1 showed an increase in the students' critical thinking skills, which indicates a positive contrast when compared to their skills at the beginning. The detailed result can be seen in Table 1.

Cycle 2

The implementation of cycle 2 was based on the results of the reflection process throughout cycle 1. What is considered a failure in cycle 1 is then improved in cycle 2 as the implementation of learning in cycle 2 is no different from cycle 1 in terms of time and stages. The only difference between cycle 1 and cycle 2 is in the student grouping model. In cycle 2, the teacher pays attention to the characteristics of students to form expert groups from various student backgrounds. This approach makes the interaction in

the core group livelier, and the learning that takes place, more effective. The topic discussed in cycle 2 is basic competency 3.4, with the title of "explaining and determining the completion of a system of inequalities of two variables (linear-squared and squared-squared)." The increase in students' critical thinking skills seen in cycle 2 was even better than the students' critical thinking skills in cycle 1.

Discussion

This study uses a jigsaw cooperative learning model as an alternative approach to improve students' critical thinking skills. The results showed that the jigsaw learning model could improve students' critical thinking skills with an average increase of 43%. With the jigsaw learning model, students are responsible for the subject matter, helping each other and interacting with fellow students so that each of them is active in the learning process (Abed, Sameer, Kasim, & Othman, 2019; Bacsal, Ibañez, & Pentang, 2022; Rosita Elmagustilla, 2021; Verma, Dhull, & Gunjan Verma, 2019; Yimer & Feza, 2019). The syntax offered in the jigsaw learning model helps students understand learning material, and as a result, can improve students' critical thinking skills. Critical thinking skills are higher-order thinking skills that require cognitive processes like analyzing, evaluating and drawing conclusions.

These cognitive activities can be encouraged through the jigsaw learning model, demonstrated by the learning procedure carried out in this study. First, the teacher explains the learning objectives and gives a brief introduction to the topic to be studied. Next, homegroups are formed whose members are heterogeneously assigned. In the third step, the teacher gives different problems to students in each home group. In the fourth step, students are guided to solve the topic problems through reading, understanding, and discussion activities with various available learning resources. In the fifth step, after finding alternative answers to the problems, each student is asked to interpret the results and ask other students if there are parts that someone still doesn't understand. . In the sixth step, the expert group was disbanded and moved to the home group to present their findings. Finally, in the seventh step, the teacher gives quizzes to students to work on individually, where students are prohibited from discussing or trying to find answers using the help of other sources. This quiz is given to measure students' critical thinking skills. Thinking activities in the form of analyzing, evaluating, and drawing conclusions occur in steps four, five and six.

The jigsaw learning paradigm is a model that is problem based and is characterized by the student presenting their students with a problem. (Schechter, 2011). When teachers present problems early in the learning process, it encourages problem-solving through analysis, evaluation, and the compilation of collected data. (Dwyer et al., 2014). Analyzing, assessing, and summarizing are also signs of critical thinking (Vong & Kaewurai, 2017). Critical thinking skills have been observed to develop when students participate in group discussions. The characteristics of the jigsaw learning model are reflected in students carry out discussions in home groups and expert groups (Evcim & İpek, 2013; Leyva-Moral & Camps, 2016). Students in the home group were involved in two tasks: identifying a problem and discussing how to solve the problem that arose in a particular case study. Conversely, in expert groups, students do exercises to find out more detailed knowledge (Artut & Tarim, 2007; Gambrari, Yusuf, & Thomas, 2015; R. E. Slavin, 1985). Discussion activities in the home group are carried out after students' complete information-seeking activities in the expert group. In this discussion, the problem-solving process requires analyzing, evaluating, and creating activities (Dwyer et al., 2014; Schoenberger-Orgad & Spiller, 2014) which are critical thinking activities (Vong & Kaewurai, 2017).

Although not all students had the opportunity to present their findings, other students were still actively involved in general discussions by providing criticism and ideas based on their findings. The students ok great care in evaluating the work of their group mates while providing comments and suggestions. This approach encourages children to engage in evaluation tasks described in Bloom's Taxonomy (Anderson & Krathwohl, 2001).

CONCLUSION

The CAR aims to improve students' critical thinking skills. The results showed that by implementing the Jigsaw cooperative learning model, there was an increase in the process of learning mathematics in both cycles. The result shows that the Jigsaw cooperative learning model can increase student activities, in understanding learning the material, discussions, and achieving learning goals. Based on the results of this study, there was also an increase in students' critical thinking skills. The implication of this research is for the improvement and innovation in learning mathematics, especially in improving critical thinking skills. In addition, teachers are also expected to apply a more advanced learning paradigm when teaching mathematics in class. For instance, the teacher can apply the Jigsaw cooperative learning model to achieve better learning than ever before.

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