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COLLABORATIVE ASSESSMENT WITH PEER FEEDBACK ACTIVITY TO IMPROVE STUDENTS' CRITICAL THINKING SKILLS

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Abstract

This study aims to improve students' critical thinking skills through collaborative assessment with peer feedback activity and to find out students' attitudes towards learning through collaborative assessment with peer feedback activity. The population in this study were first semester students of the Mathematics Education Study Program, Semarang State University, Indonesia. This research is a mixed-method research, at the quantitative stage using a Quasi-Experimental Design with two sample groups of 30 students each, and continued with descriptive qualitative research with 6 research subjects. The instrument used to measure critical thinking skills is a test in the form of a description, while a questionnaire is used to measure student attitudes in collaborative assessment learning with peer feedback activity. The findings show that there is an increase in critical thinking skills in the application of collaborative assessment with peer feedback activity. In addition, there are significant differences in students' critical thinking skills between learning by collaborative assessment with peer feedback activity and learning by individual assessment. The results of the questionnaires and interviews show that there are three important things that need to be considered, namely making students more motivated in their learning, interaction/involvement in learning is more meaningful and can familiarize students with discussions and collaboration.

Keywords: Critical Thinking Skills, Collaborative Assessment, Peer Feedback Activity.

INTRODUCTION

Problem solving is a routine part of human life. Critical thinking is an important factor in problem solving both in education and other areas of life, critical thinking is one of the most important skills in today's 21st century (Alismail & McGuire, 2015; Changwong et al., 2018). Critical thinking is very important for students because it allows them to solve problems in difficult situations and have effective and accurate communication. Learning to think critically is one of the most desirable objectives of the education system (Nilson et al., 2014; Radulović & Stančić, 2017; Tiruneh et al., 2017), this is why the term critical thinking is often found in educational policy documents. In the context of learning in Indonesia, critical thinking is one of the learning objectives, especially in learning mathematics (Basri et al., 2019).

(Akgun & Duruk, 2016)(Biber et al., 2013) has examined critical thinking skills in prospective mathematics lecturers. This finding indicates that the critical thinking skills of prospective lecturers and students are still in the low category. Other research results are expected to enable mathematics lecturers to design curricula, courses, and/or teaching practices that can improve the critical thinking skills of prospective mathematics lecturers, which in the long run can help Indonesian students have better critical thinking skills. (Tiruneh et al., 2017). Based on these opinions, critical thinking is an important skill that is needed in the world of education and the world of work. This skill ranks first on the list of required skills. Communication skills, collaboration, global awareness, mastery of technology, skills in life and career, learning ability

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and innovation require a good foundation of critical thinking. The importance of the construct of critical thinking in the world of education and work is no longer debatable.

The introduction to number theory course in the Mathematics Education study program at Semarang State University requires students to think critically, especially when proving theorems and solving problems. In order to prove theorems, students need to have critical thinking skills and analytical reasoning. In fact, the AAC&U survey in 2009 showed that 74% of respondents stated that critical thinking was at the core of learning objectives in higher education programs. (Stassen et al., 2011). Critical thinking is a very important part of learning, because in the learning process it is possible for students to gain experience using the knowledge and skills they already have to apply to solving problems that are not routine. It is expected that students will be able to demonstrate a logical, critical, analytical, careful and thorough attitude, be responsible, responsive, and not give up easily in solving problems. Students' critical thinking skills in solving problems are not as expected, therefore it is necessary to improve critical thinking skills in solving problems. So that students' critical thinking skills in proving theorems and solving problems are as expected, collaborative assessment learning with peer feedback activity will be applied.

Collaborative assessment must be part of today's educator learning. Most educators currently only focus on individual assessment, so from now on they will provide another type of assessment, namely collaborative assessment. Collaborative assessment is an important part of the learning process. When teachers use these assessments to assess students, they not only benefit the students, but also the lecturers themselves (Falchikov, 2013). Collaborative assessment is an assessment which is a means for making decisions in learning (Kelly et al., 2010; Parkison, 2014). The main ways in which students can engage in assessment are peer assessment, self-assessment and collaborative assessment (Falchikov, 2013), With this assessment students are also more involved in providing feedback to their peers. However, based on the experience of researchers, the level of student involvement still varies from those who have not been involved at all to involvement at a higher level.

Peer feedback activity is a process in which students read the work of their friends and provide comments on the work (Ekahitanond, 2013). Peer feedback activity allows students to grow and learn from each other in the form of building knowledge and understanding. Many benefits can be obtained through peer feedback activities such as timeliness of feedback, developing interactive learning for both givers and recipients of feedback, and improving the environment, including strengthening social relations in the community. Peer feedback activity leads to more flexibility and quick access to learning resources. Students also talk about experiences from various perspectives, reflect on those experiences, and apply knowledge to decision making and problem solving. This gives students the opportunity to communicate and interact with their peers, and generate information resources, negotiation of meaning, and a sense of group cohesion. (Chuaphalakit et al., 2019). Peer feedback activity involves students giving feedback to one another about what they are doing (Reinholz, 2018). Thus students will be happy to see the work of their friends and evaluate it. Giving group members the opportunity to provide feedback, this is important in collaboration where students are aware of their accountability to

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the group. Initially, students reviewed and commented on materials written by their peers. Technological tools can be used in addition to traditional methods to facilitate the process. Students can write and review their peers' writings online. Peer review tasks can be developed for individual communication exchanges or collaborative team projects. Peer feedback activity encourages students to dare to submit their work to be commented on by their peers. Time becomes more effective in learning because the discussion has been carried out in a peer feedback activity.

The problem in this study is whether there is an increase in critical thinking skills before and after using collaborative assessment with peer feedback activity, is there a difference in students' critical thinking abilities between learning using collaborative assessment and peer feedback activity with individual assessment, and how are students' attitudes towards collaborative learning assessment with peer feedback activity.

RESEARCH METHOD

This research is a mixed-method research, at the quantitative stage using a Quasi-Experimental Design with two sample groups, and followed by a descriptive qualitative research. Quasi-Experimental is an experiment that has treatments, outcome measures, and experimental units but does not use random placement (Creswell, 2012). To solve the first and second problems, quantitative research was carried out, and the third was descriptive qualitative research. The population in the study was 186 students Mathematics Education Study Program at State University of Semarang for the 2019/2020 academic year, the sample size was 60 students. The design used in this study is a quasi-experimental design with pre and posttest from Creswell (2011, 310) (Creswell, 2012) in Table 1 as follows.

Table 1: Quasi-Experimental Design

Pre-and Posttest Design → Time

Select Control Group	Pretest	No Treatment	Posttest
Select Experimental Group	Pretest	Experimental Treatment	Posttest

To answer the third problem, this research uses qualitative or naturalistic methods because it is carried out in natural conditions, where the researcher is the key instrument. Qualitative research is a research process that creates a complex picture that produces descriptive data in the form of written and spoken words and sentences from people and observed behavior from the natural environment and data collected where participants have the problem that being studied (Creswell, 2012).

According to the design in Table 1, there are two groups participating in the introduction to number theory course. The first group was the control group with no treatment and was given a pretest and posttest. The second group as Experimental Group with Experimental treatment was given pretest and posttest. The experimental group was given collaborative assessment treatment with peer feedback activity. The pre-test is carried out before students are given learning with collaborative assessment with peer feedback activity. Post-test is carried out after students get learning with collaborative assessment and peer feedback activity in online

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discussion forums. The pre and post-tests were prepared by the researcher to measure students' critical thinking skills with reference to Bloom's cognitive level. Krulik & Rudnict in (Firdaus et al., 2015) stated that the components of critical thinking skills in mathematics can be measured by looking at 3 things, namely: (1) identification and interpretation of information; (2) information analysis; (3) evaluation of information and arguments. To create an instrument on critical thinking skills covering non-routine problems. Critical thinking is a ability that consists of components: skills in analyzing arguments, making inductive and deductive conclusions, evaluating and making decisions or solving problems (Lai, 2011). Critical thinking includes reasonable and reflective thinking skills that focus on decisions about what to believe or do (Norris & Ennis, 1989). Before the instrument is used, it has been tested on its validity and reliability.

The second instrument is an attitude questionnaire related to learning activities, which investigates students' attitudes towards learning through collaborative assessment with peer feedback activity in online discussion forums. The questionnaire was tried out on 30 students who were not the target group. In this section the questionnaire is tested for validity and reliability. In order to validate the instrument, content validity was carried out and the reliability coefficient was calculated using the Alpha coefficient from Cronbach. The data obtained from the questionnaire is described by calculating the mean and standard deviation and interpreted qualitatively to show students' attitudes towards learning through a collaborative assessment model with peer feedback activity. Furthermore, the interview was conducted by looking at the four main factors, namely: what benefits are obtained through the collaborative assessment model with peer feedback activity? What are the advantages of using this learning? What is the attitude of students after participating in this learning? And what would be recommended to improve learning?

The research subjects were 4 students who were selected as representatives of students based on the results of a questionnaire about attitudes towards learning given with criteria according to (Susbiyanto et al., 2019) as shown in Table 2. Furthermore, based on Table 2, 1 student was taken in the very good category, 1 student was in the good category, 1 student was in the poor category, and 1 student was in the bad category.

Table 2: Categorization for the response questionnaire

Category	Score Range
Very good	72 – 80
Well	60 – 71
Poor	47 – 59
Bad	20 – 46

In carrying out this research, students in groups discussed completing practice questions which were a matter of critical thinking skills. Students comment on other students by giving reasons. Even though the comments given actually have little effect on work, it can influence student motivation in improving their work. Feedback from peers causes students to check back, and revise. After completing revision, students upload their work individually to the E-learning application. Students can upload work according to the discussion results, or not in accordance

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with the discussion results. In order to keep students studying well, the hope is that collaborative assessment with peer feedback activity is to help each other learn and build ideas from each other, and consider various possible answers. In this study, promoting students' critical thinking skills is a top priority, therefore students are assured to feel comfortable in learning.

The test results of the critical thinking skills instrument show that the reliability coefficient of the test is 0.73 while the reliability coefficient for the attitude variable is 0.87, and the validation results show that the instrument is valid. Based on these results the researcher decided to use an instrument to measure students' critical thinking skills and attitudes in learning using collaborative assessment with peer feedback activity. The pre-test and post-test scores were analyzed by paired t-test, after all the prerequisite tests were fulfilled. To see that there is a significant difference between critical thinking skills in the experimental group and the control group, an independent t test was used. In addition, in an attempt to learn what students think about this learning activity, students are asked to answer a questionnaire. The questionnaire was analyzed descriptively qualitative, including an analysis of the mean, standard deviation and the results of student answers to the questions given.

RESULTS AND DISCUSSION

The first problem in this study is whether Collaborative Assessment with peer feedback activity in online discussion forums can improve students' critical thinking skills in solving problems in introduction to number theory courses. The results showed that the average scores of students before and after being given the Collaborative Assessment learning treatment and peer feedback activity in online discussion forums obtained the mean for the pre-test and post-test respectively were 64 and 81. To find out whether critical thinking skills students significantly improved, pre-test and post-test scores compared by applying the paired sample t-test. The results of the calculations show that the post-test average score is more than the pre-test average score with a value of $t = 8.11$ and a significance value of 0.00. This shows that applying Collaborative Assessment learning with peer feedback activity in online discussions improves students' critical thinking skills. Improvement in critical thinking skills can be a result of practicing the Collaborative Assessment model with peer feedback activity. Students become accustomed to reasoning by expressing opinions with logical, clear, and specific reasons or examples, or using common sense, well-supported comments, or statistics to convince others. Students have the opportunity to practice giving reasons in online discussion forums.

Collaborative Assessment learning with peer feedback activity in online discussions allows students to use a high level of critical thinking. Online discussions can help students reflect, rethink and revise their problem solving content. These are all learning activities that require analysis, organization, and content evaluation (Mory, 2004). The findings also indicated that students' understanding of the content of the material, how to organize and analyze the material that was submitted lastly, was facilitated and enhanced through the process of exchanging ideas, studying together, and comparing peer responses. Findings from previous studies also reveal that reflective processes, such as critical questioning and peer feedback strategies when

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used effectively as complementary learning strategies facilitate students' critical thinking (Bai, 2009).

The second problem in this study is whether the results of students' critical thinking abilities in learning with Collaborative Assessment with peer feedback activity in online discussion forums in introductory number theory courses are better than students' critical thinking abilities with individual assessment. The results showed that the average score of students with the Collaborative Assessment learning and peer feedback activity in online discussion forums obtained a mean of 81, while for learning with individual assessment the mean was obtained 76. To find out whether students' critical thinking skills differ significantly, compared to apply the independent t-sample test. The results of the calculations show that the critical thinking skills score in Collaborative Assessment and peer feedback activity learning is significantly different from the average in learning with individual assessment, namely by obtaining a value of $t = 2.93$ and a significance value of 0.00. This value indicates that the application of Collaborative Assessment learning with peer feedback activity in online discussions is significantly different from the results in learning with individual assessment.

Developing critical thinking skills takes a long time and requires practice in learning activities. Learning resources must be contemporary, interesting, provocative, entertaining, and short, such as songs, which will be relevant and compatible with critical thinking skills. Interactive learning, which is driven by reflection and critical questioning, can help students' comprehension of content. Understanding content must occur before such higher-order thinking, analysis, synthesis, and evaluation. Higher-order thinking is likely to occur when students feel comfortable and motivated in learning in a classroom where they can confidently speak their minds, freely exchange ideas with peers, and openly accept different perspectives.

It has been proven here that critical thinking skills have increased significantly through collaborative assessment with peer feedback activity in online discussions. In addition, other skills and values, such as written communication skills, self-esteem, and tolerance for others are promoted in student learning. Learning with online discussion utilizes Elena to function as a functional and practical learning resource in one exercise to help students solve problems. This is in accordance with the writings of Carmichael, E & Farrell H (2012) that analysis of patterns of use of online sites and qualitative analysis of student feedback provides evidence to encourage students' critical thinking (Carmichael & Farrell, 2012). There is potential to expand this into a wider range of learning and learning resources that can be used in the future, and for further research to explore benefits for student learning.

The results of the interviews conducted with the first research subjects showed that with the exercises and tests carried out in a collaborative manner, those who initially felt less familiar with their classmates because they had never met them directly or indirectly. This makes it a means to get to know each other with their class mates. This learning is useful for being able to share knowledge by submitting work to be seen, commented on, and discussed with friends in the group. This student feels motivated to be able to answer questions in his group. Willing to help others, active in group work. It can even overcome when there are differences of opinion, because even in this discussion each student is free to upload which answers from the

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results of the discussion which in their individual opinion are correct. In the implementation of student discussions can encourage other students to interact and work together in completing tasks and solving problems. This discussion certainly provides benefits, among others, is someone reminds you when writing wrong or inaccurate definitions and theorems in their use, so that understanding increases and is followed by increased critical thinking skills as well. If learning uses collaborative assessment with online peer feedback in accordance with current learning, the implementation of lectures is still online.

Furthermore, the results of interviews with the second student, namely students with a good attitude category. The critical thinking skills of this student with mediocre grades is not high. The results of the interviews conducted with the third research subject showed that with the exercises and tests carried out in a collaborative manner, those who initially felt less confident dealing with their class mates because they had never met them directly or indirectly. After starting to get to know his classmate, he started to dare to ask questions even though he was a little unsure. This makes it easier for students to get to know each other because it is facilitated to interact and get to know each other with their class mates, especially in one group. As for this learning, additional knowledge can be obtained by asking each other's work to be completed, commented on, and discussed with friends who have higher abilities in their group. This student feels motivated to be able to answer questions in his group. Willing to help other students, active in group work. It can even overcome if there are differences of opinion, because in this discussion each student already knows that they can be free to upload answers that according to their individual opinion are correct and do not need to follow their friend's suggestions if they do not agree. In carrying out the discussion, students can encourage other students who are not brave enough to express their opinions to interact and work together in completing assignments and solving problems.

The results of interviews with the third subject are students who have a good rating and the value for their critical thinking skills is mediocre, not too high. The student stated that he was happy to do something good and had a habit of following the prevailing norms, including asking permission from his friends when he was going to give an opinion. This student will wait for other friends to express their opinion and then ask for permission to argue. His involvement in the discussion was quite active.

During the discussion, he is always willing to help his friends sincerely, even though when he doesn't understand, he only expresses support for the opinions of other friends as a form of support so that his friends are always motivated in discussing. In the event of a difference of opinion during a discussion, students will remain silent and after finishing will mediate by saying that all opinions are basically good, it is best to just ask the course lecturer. Encourage other friends to keep working together, helping each other in this case in completing tasks together. The benefits obtained in this activity include knowing each other well and interacting well between group members, being able to share together, and more importantly understanding how to complete tasks correctly.

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The results of interviews conducted with the fourth research subject, namely students whose attitudes were not yet in the good category, were almost the same as the previous subjects. It was shown by the existence of exercises and tests that were carried out in a collaborative manner, which at first felt that they did not know their group mates because they had never met them directly or indirectly. This makes it a means to get to know each other with their class mates. This learning is useful for getting suggestionthed by paying attention to the work of his friends. Seeing his friends discussing and commenting on each other, this student felt motivated to be able to try to do the work of his friends in his group, even though he was a bit lacking in confidence.

This students try and are willing to help others, and try to be active in group work. Even trying to understand if there are differences of opinion, because in this discussion there is already an agreement that each student is free to upload which answers from the results of the discussion which in their individual opinion are correct. In carrying out student discussions can encourage other students to interact and work together in completing assignments and solving problems.

This discussion certainly provides benefits, among others, is that someone warns when writing down definitions and theorems that are wrong or inappropriate in their use, someone teaches them if they don't understand, so that understanding increases and is followed by increased critical thinking skills as well.

Overall, most of the students in this study expressed a positive attitude, motivated in learning. For them, collaborative assessment with peer feedback activity provides increased opportunities to practice solving problems and improve critical thinking skills. Students are generally more motivated and eager to learn, read, and study by discussing and using the internet and satisfying their curiosity about the posts and comments of their friends. Freedom in giving more comments to other friends makes learning motivation higher. Especially when they see and explore other posts and compare each other's work. Students start with new ideas and it is better to revise them.

Here are some of the responses expressed by students. It's great to review other posts and compare to their work, it makes them willing to improve their work and understand what is considered correct work and what isn't. They enjoy class because they are allowed to express different opinions as long as they can justify the answer. They also like being offered the opportunity to review and redo each other's work. When the class atmosphere is fun, it motivates to learn more. Some of them make practical recommendations for improving practice.

Studies conducted at the undergraduate level have shown that collaborative assessment improves students' depth of understanding, critical thinking skills, and exam performance, likely as a result of students engaging with their peers to discuss questions and answers, thus filling in knowledge gaps (Vogler & Robinson, 2016). Working in collaborative groups increases assessment scores than taking exams individually (Bremert et al., 2020). Additionally, students indicated that they believed working collaboratively to answer assessment questions increased their understanding, which they then applied to the AP exam

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(Bremert et al., 2020). Based on the semester scores that students have, it is believed that students use collaboration time to better understand the material and not drain their energy because they still need to demonstrate their understanding in exams and final semester exams (Bremert et al., 2020)

Collaborative assessment, in which pairs or small groups of students work together, allows students to benefit from their peers' knowledge and teacher feedback in the same activity (Cooper, 2017). Successful collaboration can enhance students' understanding by encouraging them to defend their thinking, thereby building their metacognition skills (Cooper, 2017).

In addition, collaborative learning has many benefits in the field of mathematics education (Asha & Hawi, 2016). This is in accordance with the 21st century 4C competencies that students must possess, namely critical thinking and problem solving, creativity, communication skills, and ability to work collaboratively (Setiana et al., 2021). Students as prospective lecturers in mathematics have increased their critical thinking skills. This shows that mathematics has a potential role for the development of thinking, including critical thinking. Therefore, mathematics lecturers play a very important role in this work. Mathematics lecturers have the potential to help their students develop critical thinking skills.

Students as prospective mathematics lecturers can show that mathematics has a potential role for the development of thinking, including critical thinking. Therefore, mathematics lecturers play a very important role in this work. Mathematics lecturers have the potential to help their students develop critical thinking skills (As'ari et al., 2017).

CONCLUSION

The results showed that there was an increase in critical thinking skills in the application of collaborative learning with peer feedback activity. Based on the results of this study it can be concluded that the implementation of problem solving exercises and tests in learning by applying collaborative learning with peer feedback activity is proven to be able to improve students' critical thinking skills in the mathematics education study program at Semarang State University in the Introduction to Number Theory course.

It is also proven that this learning can motivate students to take part in introductory number theory lectures, besides that there is good interaction between students, so that they can complement each other's work in the group. Especially if all students need each other in their groups, even though the interactions occur online. The habit of discussing and collaborating makes students motivated in learning and results in increased ability to think critically.

In the implementation of learning in the following years it is suggested that for the implementation of exercises, quizzes, apply collaborative learning with peer feedback activity. Improvements to research instruments, implementation of learning, and assessment need to be done. It would be nice to be able to combine learning with learning approaches and models inside and outside the classroom to serve various needs and make learning fun for students. The results of this study will be used by researchers as the beginning of the next research.

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