Analysis of Students' Critical Thinking Ability Based on Sense of Belonging to Mathematics

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Abstract. This study aims to analyze students' critical thinking ability in introduction to number theory courses based on their sense of belonging mathematics. The learning model used is the Issue Rule Application with online Collaborative Assessment. Critical thinking ability are needed in learning mathematics, especially in introduction to number theory courses. Make grow a sense of belonging to mathematics is fundamental in educational research, regardless of other factors. Online learning certainly provides flexible learning opportunities but comes with important issues in the current pandemic. For online learners, maintaining a sense of belonging to mathematics can provide a way to enhance learning experiences and achievements. This research is a qualitative or naturalistic research because it is carried out in natural conditions that produce descriptive data. Interviews were conducted on 6 students after collecting data on critical thinking skills using a test and sense of belonging mathematics using a questionnaire. The results showed that students with a high sense of belonging to mathematics did not always have high critical thinking skills, students with moderate sense of belonging to mathematics had moderate critical thinking skills, students with low sense of belonging to mathematics had low critical thinking skills and some had low sense of belonging to mathematics. Also high. This happens because students in the first semester still need to develop a sense of belonging in mathematics by providing continuous motivation, optimizing interaction/involvement in learning, and having a fun learning culture.

Key words: sense of belonging to mathematics; critical thinking ability.

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INTRODUCTION

Critical thinking skills are the basic intellectual capital for everyone. Therefore, critical thinking skills are very important for students at every level of education (Howard et al., 2015). Students are required to be able to provide learning that is able to grow students' character to think critically, creatively, able to communicate, and collaborate. This is in accordance with the 21st century 4C competencies that students must have, namely critical thinking and problem solving, creativity, communication skills, and the ability to work collaboratively. (Zubaidah et al., 2015). This is also in accordance with what was stated by Kivunja (2015) which states that creative, critical thinking, independent, able to work with teams, creativity, information, communication and independent learning are competencies that must be mastered by every individual to face the 21st century. Critical thinking skills are one of the life skills that students must have. Having critical thinking skills will help students solve simple or complex problems. Critical thinking allows students to find the truth and process information logically so that they can determine which information is important, irrelevant, or useless (Antika, 2017). Critical thinking skills are needed by individuals to deal with various problems faced in their social and personal lives (Nuryanti et al., 2018). Ennis explained critical thinking is a process that aims to make decisions so that what people think is the best about a truth and they can do something right. (Ennis, 1993). Critical thinking is an important skill that helps students improve their ability to make judgments, inform well, explain reasons, and solve unknown problems (Facione, 1991). Masek and Yamin (2012) further state that critical thinking is the ability to analyze and evaluate information and ask important questions. Critical thinking leads to valid arguments and conclusions.

The main theory of critical thinking in this research is the development of critical thinking proposed by Ennis (Ennis, 1993) through the six elements of critical thinking that are synchronized into the acronym FRISCO (Focus, Reason, Inference, Situation, Clarification, and Overview). Current technological advances allow students to study online while still interacting with friends in one group, can attend lectures in

full, and can still participate in classical discussions. While there are those who think that online learning requires a higher level of self-motivation, in this case mathematics majors recognize the importance of providing the same material in face-to-face learning or online learning and are very careful to ensure that students receive the same level of support. the same as they would receive on campus. Learning in this material uses the Issue Rule Application Activity Assessment learning model, which is a learning model that pays attention to the latest conditions, namely online learning and prioritizes mastery of definitions and theorems that have been studied to solve critical thinking skills problems with collaborative assessment. The spread of the virus in different countries, forcing all to see the reality that learning around the world is changing. Not only in learning, it can also be seen how the changes in the fields of technology, economy, politics and education. This change requires to be prepared, respond with attitudes and actions while always learning new things. Indonesia is not alone in finding solutions for students to continue to learn and fulfill their educational rights.

According to Suharwoto (2020) with online learning there are challenges, namely (1) teachers must master technology in order to teach remotely; (2) the use of technology is not arbitrary; (3) online learning patterns must be part of all learning; (4) must have online learning equipment; (5) the digital infrastructure gap between big cities and regions must be bridged with affirmative technology policies. The existence of these challenges makes online learning in its implementation better. In offline learning, of course, lecturers are not fully required to carry out these challenges, because in offline learning the lecturer can provide external motivation that makes students feel comfortable in learning mathematics. In addition, learning interactions between lecturers and students as well as students and students occur well, discussions in learning in class also occur well in academic and non-academic activities. This is in accordance with Meehan's opinion (2020) that face-to-face learning on campus, students with a strong sense of belonging feel comfortable and involved with their studies, and consider social and cultural values to be in line with the university's vision. Students are generally more motivated and have a strong belief that they can achieve and will excel. Good (2011) conceptualizes a sense of belonging to mathematics as the involvement of one's personal feelings about membership and acceptance in an academic community where positive influence, trust levels, and willingness to be involved remain high. In a study on undergraduate students majoring in mathematics, it was shown that SBM reliably predicts a person's intention to study mathematics in the future. Thus, this lack of belonging to students can lead to feelings of anxiety, frustration, and boredom, which negatively impacts their lives and academic performance. This has the potential to occur in situations where their values and needs appear unappreciated. Therefore, students' sense of belonging to mathematics needs to be explored so that students' intention to learn mathematics is very high.

The problem in this study is how students' critical thinking skills in introductory number theory courses are based on a sense of belonging to mathematics.

METHODS

To answer the problems in this research, qualitative or naturalistic methods are used because they are 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 the people and observed behavior. This research is a qualitative research because it fulfills the characteristics of qualitative research (Creswell, 2014), namely the natural environment and data collected where participants experience the problem being studied.

Research Subject

The subjects in this study were the first semester students of the Mathematics Education study program as many as six students. The sampling technique used purposive sampling; the determination of research subjects was based on the results of a questionnaire that had been given to previous students. Questionnaires about sense of belonging to mathematics were given to first semester students in the first year. Based on the results of the questionnaire, each student who represents various opinions has the same score about the sense of belonging to mathematics based on feelings of membership, acceptance by the community, positive influence, trust, and desire.

Research Instrument

The instruments in this study were tests, questionnaires, and interview guidelines, tests were used to measure students' critical thinking skills, questionnaires were used to measure the sense of belonging to mathematics, and interview guidelines were used as guidelines in revealing students' critical thinking skills based on their sense of belonging. to mathematics. A test is given to students in the Introduction to Number Theory course and the results of the questionnaire are used to determine research subjects who represent the various opinions that are the same among students. The instrument is based on the opinion of Good (2011). The factors that influence the sense of belonging to mathematics include feelings of membership and acceptance in the mathematics domain. In addition, following the opinion of Peacock (2020) the most frequently cited and accessible definition of education regarding sense of belonging is the emphasis on feelings consisting of being accepted, valued, included, and encouraged by others (teachers and peers) in academic classes. and feel themselves as an important part of life and classroom activities. More than just a feeling of love or warmth that is felt, it also involves support and respect for personal autonomy and students as individuals. According to Davis (2019) the sense of belonging index developed includes two aspects of ownership: belonging to the institution and belonging to the department, which are referred to as social belonging and academic belonging respectively. According to Meehan (2018), the factors that influence students in relation to school and university mathematics include their desire and experience in studying mathematics, how confident they are, and whether they feel part of the mathematics community. Based on these opinions, the focus of this research is set on 5 indicators in measuring the sense of belonging of mathematics students in the mathematics department, namely feelings of membership, acceptance by the community, positive influence, trust, and desire.

Data Analysis

After the data is collected, the process of analyzing the data obtained from interviews, notes and others is carried out by systematically organizing through the stages of data reduction, data presentation, data interpretation and drawing conclusions and verification so that it is easy to understand. The systematic steps that will be carried out are: 1) processing and preparing data for analysis; 2) read and examine the entire data, so that it is hoped that a general idea will emerge from what the data sources have said. This is quite important so that the depth of the information can be understood properly; 3) to get a deeper analysis to obtain specific terms that come from data sources; 4) describe specific terms so that they are easy to present; 5) interpret / interpret the data and make conclusions based on the data that has been collected.

RESULTS AND DISCUSSION

The results of the critical thinking ability test showed that of the 7 test items, the average test result was 37 with the highest score of 62 and the lowest score of 21, and the results of the questionnaire obtained an average of 112, the highest score of 132 and the lowest score of 84. From the interview results It is known that all students gave positive responses to the questions about the sense of belonging mathematics given, and also about the implementation of online learning, where material was given through Elena, namely e-learning owned by Semarang State University. Students are introduced from the outset about their roles and responsibilities in the online community. They are expected to be able to participate every week in individual and structured group activities under the guidance of the course lecturers. Interviews were conducted independently, the confidentiality of the survey and interviews were conducted in the hope of bringing out honesty from students. Semi-structured interviews were conducted online using appropriate social media owned by students. Responses to each question in the survey are grouped into meaningful sections according to indicators by omitting student identity to ensure data confidentiality. When students were asked whether a sense of belonging to mathematics was important for them as online learners, all of them answered that it was important then continued with the next questions by reducing the parts that were less meaningful and checking based on the results of the questionnaire and information from sources. others that can be trusted and support the previous findings. All interviewed students also said that they have a need and desire to be able to connect and relate to their friends, especially classmates and moreover with friends who are in the same group, and also want to interact directly with course instructors. Individuals' need for a sense of belonging varies as they study in unusual environments such as online learning. Students'

sense of belonging to mathematics seems to be related to the psychological and social dimensions, which involve feelings of being accepted in their group, needed, respected, and valued in their respective classes. Besides that, it is also related to feeling comfortable with their classmates, comfortable in their majors, and comfortable in their institutions. In general, they all also said that it was important to have involvement and collaboration with their friends to foster a sense of friendship from before who did not know each other because their regional origins varied from all over Indonesia, which physically cannot meet face-to-face during a pandemic with online learning as it is today. They also cannot be part of the desired community as in the student community in general, let alone develop activities in their community. The implementation of online learning carried out in lectures uses Elena's communication media, whatsapp, and Google Meet. Online discussions on core activities were carried out through Elena, but according to students the discussion in this forum was not optimal, as if learning was carried out face-to-face, especially during group discussions. The course instructors, in this case, were directly involved in influencing the sense of belonging to mathematics, identified from all the students who said that it was the glue that united students through friendly behavior, various assistance, encouragement, feedback and enthusiasm, as well as helping to strengthen a sense of belonging by being present. continuously during online learning. Student involvement and interaction in lectures is also important, discipline in posting the results of assignments, both individually and in groups, is also an important element so that students can get to know their friends.

The first student, a student with a high sense of belonging mathematics category, said based on his feeling that the lack of regular meetings and socialization such as face-to-face learning is an important part that makes students less motivated in online learning. Moreover, previously, students did not know each other and did not know the supervisor of all courses. In addition, these students also feel normal when accepted in the mathematics department. Starting college in the first semester of his first-year majoring in mathematics, his feelings were also ordinary, he didn't even feel like he had knowledge of mathematics. Although with online learning, he feels that his seniors in the mathematics department accept them well, so also the lecturers in the first semester according to his feelings have tried to build good relationships with students with limited time in online learning meetings through social media every week. Students' critical thinking skills are in the high category, the scores obtained by students tend to be always good, they don't seem to have difficulties in solving problems, especially on questions about critical thinking skills. In solving problems, always focus on the right ways. Always write down what is known and what is asked and understand exactly what is known and what is being asked. Understand the definitions and theorems needed to prove theorems and solve problems. This student is able to find ideas and determine specific steps in proving a theorem and make a decision to use definitions and theorems to prove the next theorem. The results obtained are correct proofs ranging from material divisibility to congruences.

The second student is a student with a high sense of belonging to mathematics who lives outside the city and is also far from campus. This student also said that based on the feeling of lack of regular meetings and socialization such as face-to-face learning is an important part that makes students less motivated in online learning. Moreover, previously, students did not know each other and did not know the supervisor of all courses. In addition, these students also feel normal when accepted in the mathematics department. Starting to study in the first semester in the department of mathematics, his feelings were also ordinary, he did not even feel that he had knowledge of mathematics. Although online learning has felt that his seniors in the mathematics department have received it well, so also the lecturers in the first semester according to his feelings have also motivated and tried to build good relationships with students with limited time in online learning meetings through the media. social every week. Interaction with other friends as well as with course instructors is still very limited. Students' critical thinking skills are in the medium category, the scores obtained by students are not always good, they seem to have a little difficulty in solving problems, especially on questions about critical thinking skills. In solving problems, even though you have focused on the right ways, you are still wrong in applying them. Sometimes they do not understand the definitions and theorems, but once they are explained again, they are able to apply them to solve problems. This student has started to get used to writing what is known and what is

asked. This student, if they understand the definitions and theorems, can determine the specific steps in proving a theorem and make a decision to use the definitions and theorems to prove the next theorem. The results obtained are correct proofs ranging from material divisibility to congruences.

The third student with a sense of belonging to mathematics was happy when he was accepted as a student in the Department of Mathematics, and also felt happy when he started his first semester of study in the Department of Mathematics even though he did not feel comfortable with his classmates. Studying mathematics in the Department of Mathematics does not yet fully have the knowledge of mathematics but is passionate about learning and continues to study until graduating from graduate school. Students also understand that their seniors receive their juniors with open arms full of friendship. A good relationship began to be felt between fellow students, with their seniors and also with the course supervisors. Studying in the Department of Mathematics has a positive effect on his life goals to be higher by starting to recognize his strengths and weaknesses. Knowing his shortcomings and his skills encourages him to achieve success with optimism even though success is not easy to achieve. This student's critical thinking ability is classified as moderate, the score obtained by the student is not very good, seems to have difficulty in solving problems, especially on questions about critical thinking skills. Even though these students are getting used to writing what they know and what is being asked, sometimes they don't understand the definitions and theorems. Therefore, it makes students not suitable to determine specific steps in proving a theorem. The results obtained are evidence that is not true starting from the material divisibility to congruences.

The fourth student with a sense of belonging to mathematics is feeling very happy when he is accepted as a student in the Mathematics Department, and also feels happy when he starts his first semester of study in the Mathematics Department even though he has not interacted optimally with his friends, classmates and eye educators. studying. Studying mathematics at the Department of Mathematics has started to like mathematics and will continue to study at the Department of Mathematics and continue to study with a new enthusiasm until graduating from graduate school. Students already know that in the Mathematics Department there are many activities outside of lectures that can be participated in, including PMC, MCC, MSC, The Mate and others, they want to immediately know what life and learning culture is like on campus. but have not tried to be a member of one of these activities and even want to know how the college culture on campus is. Students also understand that their seniors receive their juniors with open arms full of friendship. A good relationship has begun to be felt between fellow students, with their seniors and also with the course supervisors even through online learning. Studying in the Department of Mathematics has a positive effect on his life to be more disciplined and has begun to recognize his strengths and weaknesses. By knowing his shortcomings and the skills he has, he encourages him to achieve success with optimism, even though he is well aware that success is not easy to achieve. In the future, they already have the desire to work in accordance with what they are currently engaged in, namely to become mathematics teachers, students also have aspirations to be able to continue their studies to the S2 and S3 levels. This student's critical thinking ability is moderate, the score obtained by the student is not very good, seems to have difficulty in solving problems, especially on questions about critical thinking skills. Even though these students are getting used to writing what they know and what is being asked, sometimes they don't understand the definitions and theorems. Through discussion with the guidance of their group friends help in understanding the material. The results obtained are correct proofs ranging from material divisibility to congruences.

The fifth student had a feeling of displeasure when he was accepted as a student in the Mathematics Department because it was not in accordance with what he wanted. Even though he wasn't very happy yet, when he was studying in the first semester, he started to feel comfortable with his friends in his group. Studying mathematics in the Department of Mathematics is starting to feel the benefits of having knowledge of mathematics, many people around them believe that students can start helping students in their environment to learn mathematics and have a passion for learning and continue to study until they graduate. A good relationship began to be felt between fellow students and their seniors and also with the course supervisor, although it was still not optimal. Interaction in lectures, especially in group discussions, is not easy to do, but it can still be done with all its limitations. Studying in

the Department of Mathematics began to have a positive effect on his life goals, which at first did not really like to study at the Department of Mathematics. This student's critical thinking ability is classified as moderate, the score obtained by the student is not very good, seems to have difficulty in solving problems, especially on questions about critical thinking skills. Even though these students are getting used to writing what they know and what is being asked, sometimes they don't understand the definitions and theorems. Through discussion with the guidance of their group friends help in understanding the material. The results obtained are correct proofs ranging from material divisibility to congruences.

The sixth student had a feeling of displeasure when he was accepted as a student in the Mathematics Department because it was not in accordance with what he wanted. Although not so happy, when studying in the first semester, he continued to attend lectures well and with discipline. Studying mathematics in the Department of Mathematics is starting to feel the benefits of having knowledge of mathematics, many people around them believe that students can start helping students in their environment to learn mathematics and have a passion for learning and continue to study until they graduate. A good relationship began to be felt between fellow students and also with the course supervisor, although it was still not optimal. Interaction in lectures, especially in group discussions, began to play an active role. Studying in the Department of Mathematics began to have a positive effect on his life goals, which at first did not really like to study at the Department of Mathematics. This student's critical thinking ability is classified as good, the scores obtained by students are not good, they do not appear to have difficulties in solving problems. This student has started to get used to writing what is known and what is being asked, definitions and theorems are also easy to understand. Through discussions with the guidance of their group friends, they help in understanding the material, and even tend to be tutors for their friends. The results obtained are proof and correct problem-solving ranging from material divisibility to congruences.

The existence of students who do not feel happy to be accepted in the Mathematics Department is because students are still in their first year of college, and lectures are directly online, this causes them to be less motivated in learning mathematics. Students in this group still think very ideally, still want to try again the following year to enroll in another study program that according to their thinking is in accordance with their wishes to be accepted in a study program other than the mathematics education study program. This makes the students' sense of belonging to mathematics in this group low, and in the first year of college it tends to be even lower. It is not surprising that he does not really want to study mathematics at university, this is in accordance with Meehan's (2018) opinion that this group actually does not fully want to study in the mathematics education study program. In contrast to the other groups who feel very happy when accepted and study in the mathematics study program, they are proud to be members of the mathematics education study program. This happens because what is obtained is in accordance with his wishes, the motivation given by the tutor seems to have a positive effect on the way of learning mathematics. Lecturers of courses can effectively help online to develop and maintain a sense of belonging Tuesday students are studying, the importance of being attentive and enthusiastic even from a distance. An early introduction to college can help build and develop trust and maintain good relationships and motivate students. The initial meeting before the online discussion for student representatives can introduce themselves and share their experiences, reasons for doing the study, long-term goals, assist in group formation, and collaborative activities where students can work together with other students. Even though they have never physically seen each other, they can actually get a glimpse of the other person's personality from their interactions and feel like they belong to an online community. Learning in groups in interacting with other students is seen as a way that can increase their sense of belonging to mathematics because students are expected to actively collaborate with other students to achieve their goals until the end of the lecture. In group work, students who have advantages will be able to help other students and it feels like being together in a class. This is in accordance with Peacock's (2020) opinion that student online discussions are another strength in developing a sense of belonging to mathematics, with student involvement in discussions, feedback is like getting to know each other even though it doesn't take place in real time.

In face-to-face learning on campus, students usually feel comfortable in the learning environment where students can meet their

friends and also the lecturers from each of the courses they take. Cultural values that exist on campus such as interacting with other students, discussing, studying in the library can be done on campus. Students with such circumstances are generally more motivated and have confidence that they will be able to achieve the desired achievement, with no sense of belonging to mathematics cause feelings of anxiety, boredom, which can have an impact on his life and academic performance. There are many problems that students want to overcome in the era of online learning, but with all the limitations it cannot be done. Some students can find online learning to be an interesting experience, but some feel that they can't interact with other people, collaborate with other students in learning, almost all students want learning on campus, this is in line with Winarti's opinion (2021). Of course, this is understandable for students in their first academic year, they want to experience the learning culture and life on campus.

CONCLUSION

Based on the results of the study, it can be concluded that all students said there was a lack of interaction between students and students, as well as between students and lecturers. They also said that they wanted to go to college soon and know the culture of studying on campus. The first student's sense of belonging to mathematics is not good as well as the second student, but the second student still has a desire in other fields and will fulfill his dream by working hard and still trying to find other dreams. The third and fourth students have a moderate sense of belonging to mathematics, the third students are better because they think that to successfully complete and work according to the Mathematics Education study program, they must work hard and have a strong desire to work in accordance with what they are currently engaged in, while students the fifth and sixth with a good sense of belonging to mathematics, since the beginning of the first year, they are very happy to be accepted and study in the Mathematics Education study program, and have a desire in the future to work in accordance with what they are currently doing. This student's sense of belonging to mathematics is easy to change, therefore efforts need to be made to improve it from year to year. Sense of Belonging to Mathematics is something that is quite complex, there are several factors that influence it consisting of: 1) feeling of membership; 2) acceptance by the mathematics community, one student may belong to several communities; 3) positive influence on the student environment; 4) other people's belief in mathematical abilities; 5) wishes in the future. In addition to these factors, there are three things that need to be considered in order to increase the sense of belonging to mathematics, namely: 1) interaction between students and with course supervisors; 2) learning culture on campus; 3) learning motivation. To find out how students' Sense of Belonging to Mathematics is in the second year, it can be done by improving interactions in online learning, introducing more optimal culture on campus, and increasing student learning motivation.

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