IJEMS: Indonesian Journal of Education and Mathematical Science
2023 Vol. 4, No. 1, pp. 1-6
ISSN(e): 2715-985x
DOI : http://dx.doi.org/10.30596%2Fijems.v4i1.13158

STUDENT CRITICAL THINKING SKILLS IN THE IMPLEMENTATION OF DISCOVERY LEARNING AND INQUIRY-BASED LEARNING

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Article History
Received:
Revised:
Accepted:
Published:

Keywords
Critical thinking skills, discovery learning, Inquiry based learning,

ABSTRACT

This study aims to determine the differences in critical thinking skills that are significant in the Basic Concepts of Mathematics course in learning using the Inquiry and Discovery Learning models. This research was a quasi-experimental study with a nonequivalent control group design. The study population was students of the Elementary School Teacher Education Department, Faculty of Education and Teacher Training, Universitas Muhammadiyah Sumatera Utara, with a total of 66 students. The data collection technique used the integrated critical thinking skills rubric instrument of description questions. The data analysis technique used the t-test with the Independent Sample T Test technique. The results of this study indicate that the level of critical thinking skills in learning using the Inquiry model is higher than Discovery Learning. This can be observed from the results of the t-test which shows a probability value of 0.000. By this, the probability value is < 0.05. It means H0 is rejected and Ha is accepted. This means that there are significant differences in the Inquiry and Discovery Learning models for critical thinking skills in mathematics

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1. INTRODUCTION

Rapid progress in the world of technology has had a major impact on the development of education in Indonesia. Considering that the upcoming 4.0 Industrial Revolution requires the adaptability of all components of education, this development must be taken seriously. The Industrial Revolution itself is a challenge to switch from traditional learning systems to modern learning. Every component of education must achieve new breakthroughs that require high creativity. Lecturers play an important role in higher education in fostering student creativity to overcome these challenges. The creativity shown by students is a barometer of their learning progress in class. Students who are very creative tend to be enthusiastic and confident when facing the demands of the Industrial Revolution 4.0.

At the higher education level, especially the Elementary School Teacher Education Study Program (PGSD) Muhammadiyah University of North Sumatra, it embodies the various forms of creativity demanded by the Industrial Revolution 4.0. Each course offered to students is structured from a competency performance perspective that requires creativity. The achievement of these competencies can be seen in the results of individual student learning as a result of creative thinking (Nasution, M.D and Nasution. E, 2018).

Elementary Mathematics Basic Concepts course is one of the courses that students must complete in the second semester. This course will facilitate students' understanding of theory and practice: regional autonomy as a background for KDM, basic concepts of mathematics in elementary schools, management of components of learning mathematics in schools, implementation of basic concepts of mathematics in schools, effectiveness and efficiency of KDM courses.

However, from observations during learning, it turns out that many students are still monotonous in their learning, students only rely on instructions from the lecturer, and do not have the initiative to come up with ideas and ideas in their learning. Moreover, students are accustomed to the conventional learning process, the process of one-way educational activities (Teacher Center). In conventional learning, lecturers are more dominant in controlling the class (Nasution, M.D. 2021).

Elementary Mathematics Basic Concepts course is considered quite difficult because it is a compulsory subject for second semester students who do not have other basic knowledge. A preliminary survey of KDM course students in the 2022/2023 even semester revealed that only 45% of students were self-motivated learners, 53% of students were very curious, and 48% of students had and liked challenges, and only 47% were willing to take risks.

The percentage data shows that students lack initiative, lack curiosity, and do not like challenges. The percentages above are quite serious problems, so a breakthrough is needed in the learning model or method used to increase student creativity in the learning process.

The learning carried out in the Elementary Mathematics Basic Concepts course uses methods and models that are oriented towards conventional learning so that the dominance of the lecturer as a teacher looks more dominant in learning. This makes students become monotonous in learning, students are not motivated to express their opinions and views to argue with each other about the problems they study, causing low student achievement. So, there needs to be a breakthrough and new encouragement in the application of methods or models that encourage students to increase student learning creativity in the Basic Mathematics Concepts course, so that this can have an impact on student learning outcomes (Nasution, M. D., & Sari, E. T., 2019).

Mulyasa, (2011) states that creativity or invention is a personal perception of novelty and value-based evaluation as a result of individual or collective action. From this theory it can be said that the actions of individuals or groups of people can produce new works or develop existing works.

According to Rahmawati and Euis (Rachmawati & Kurniati, 2012) creativity is an act of intelligence associated with discovering something new and being open to new experiences. Student creativity is always synonymous with intelligence, with intelligence they are able to solve problems according to various situations in the learning environment they face, ranging from easy to difficult situations. Students can always find alternative answers to solve a problem in learning.

Mark A and Garrett, (2012) stated "creativity requires both originality and effectiveness". In this case creativity can be seen from two things, namely the problem of originality and effectiveness. So a student is called a creative person if he has fulfilled the elements of originality and effectiveness.

The importance of attractiveness and student creativity in learning requires efforts made by lecturers to encourage mastery of student learning creativity. The impetus for mastering student learning creativity in question is through the application of Inquiry-Based Learning and Discovery-Based Learning.

According to Jerome Bruner (1961), inquiry-based learning is commonly known as discovery learning and science teaching based on inquiry. The process of discovery learning is that they have to identify key principles for themselves rather than just accepting the teacher's explanation. Bruner also believes that a person has three means of achieving understanding, namely enactive, iconic and symbolic ways.

The basic concept in inquiry-based learning is related to the process of personal discovery by students. Learners or student inquiry are guided to ask questions or generate relevant questions and produce appropriate answers through critical thinking. In inquiry learning students are also shown how knowledge is generated, how it is transmitted, and how all parties including experts, lecturers, teachers, parents and the community contribute to students' knowledge. Inquiry-based learning teaches students to respect their own interests and the interests of others (Donham, 2001).

The fundamental approach to inquiry learning is based on constructivist learning theory. Constructivist learning strategies utilize inquiry-based learning and problem solving through critical and creative thinking. According to Asselin et

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al (2003) student inquiry is encouraged to explore new ideas and understandings through personal discovery and exploration as well as interactions with objects and other people. Learning is enhanced through opportunities for investigators to engage in real-life activities, situations and with real audiences.

Meanwhile, the discovery-based learning model is a method that encourages students to reach conclusions based on their own activities and observations. This method means students as problem solvers where students collect, compare, analyze information, and conclude it.

Discovery learning is the recommended method of the 21st century. This method allows students to seek information and build their knowledge by doing several activities. Since, Indonesia held a new curriculum. One of the recommended methods includes the discovery learning method. Discovery learning is a suitable method in the 21st century where students must learn actively. This discovery learning method not only helps students increase their academic scores but also this method can make students have a good attitude by carrying out all processes using this method in the teaching and learning process. Continuous discovery learning can help students build their character (Feriyanti, 2014)

From the two Inquiry-based learning and Discovery-based Learning methods, according to Matson (2006) in the journal A.G Balm entitled "The Effects of Discovery Learning on Students' Success and Inquiry Learning Skills", inquiry and discovery-based learning is a process of investigating the nature and structure of the universe. Lecturers only provide stimulus and students try to find conclusions by carrying out several activities such as observation, gathering information, interviews, and others.

2. METHODOLOGY

This study used an experimental research method with Quasi 3 classes. The experimental research motto with Quasi is to measure the difference in responsiveness between the treatment group and the control group which is a measure of the influence of the treatment given to the treatment group (Margono, 2007: 110). The subjects of the research were even semester students in the Elementary School Teacher Education Study Program for the 2021/2022 academic year who took basic elementary math concepts courses. The object of research is student learning creativity. The instrument in this study was in the form of student learning outcomes tests which were demonstrated through student creativity in thinking. The tests given are in the form of essays with Cognitive levels C4 (analysis) and C5 (evaluation) which are given in writing. After the data was obtained, analysis prerequisite tests were carried out, namely the normality test and homogeneity test. After calculating normality and homogeneity, data analysis is carried out to test the hypothesis. The test is intended to determine whether there is a significant difference between student classes using Inquiry-Based Learning, Discovery-Based Learning and Conventional models. This hypothesis test is carried out using the t test formula. The t test was carried out to test the research hypothesis regarding the effect of each independent variable partially on the dependent variable (Ghozali, 2016).

3. RESULT AND DISCUSSION

A. Test the hypothesis of Inquiry-Based Learning model class groups and conventional class groups

The calculation results obtained tcount of -0.28 with degrees of freedom (dk) = (n1 + n2 – 2) = (26 +22 – 2) = 46 then obtained $ttabel$ at a significant level of 0.05 of 1.67666 because tcount< $ttabel$ (-0.28<1.67666) means that $H0$ is accepted and Ha is rejected, so it can be concluded that there is no difference in creativity with the Inquiry-Based Learning model and the creativity of conventional model classes. Meanwhile, when viewed from the results of the N-Gain creativity to determine the level of effectiveness of the Inquiry-Based Learning model and conventional models, it can be seen as follows.

Table 1. Recapitulation of N-Gain Values of Inquiry-Based Learning and Learning Models

Model	N-Gain	Information
Inkuiri-Based Learning	27,00	Ineffective
Conventional	35,00	Ineffective

Based on N-Gain data on learning creativity, both models have N-gain which is in the ineffective category. Even so, the conventional learning model has a greater N-gain value than the Inquiry-Based Learning learning model.

B. Test the hypothesis of Inquiry-Based Learning model class groups and conventional class groups

Based on the calculation results obtained tcount of 1.17 with dk (degrees of freedom) = (n1 + n2 – 2) = (22 + 26 – 2) = 46 then obtained `$ttabel$ at a significant level of 0.05 of 1.65107. Because tcount<ttable (1.17<1.65107) means that H0 is accepted, therefore it is concluded that there is no difference in student creativity with the Discovery-based Learning model and the conventional model. Meanwhile, the N-Gain results from creativity to determine the level of effectiveness of Discovery-based Learning models and conventional models are shown as follows:

Table 2. Recapitulation of the N-Gain Value of the Discovery-based Learning Model and the Conventional Learning Model

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Model	N-Gain	Information
Discovery-based Learning	62,00	Ineffective
Convensional	35,00	Ineffective

Based on the N-Gain data of learning creativity, the Discovery-based Learning model is a quite effective learning model while the Conventional learning model is categorised as ineffective.

Table 3. Recapitulation of the N-Gain Value of the Inquiry-Based Learning Model and the Discovery-Based Learning Model

Model	N-Gain	Information
Inkuiri-Based Learning	27,00	Ineffective
Discovery-based Learning	62,00	Ineffective

Based on the N-Gain data, the learning outcomes of the Discovery-based Learning learning model are quite effective learning models while the Inquiry-Based Learning learning model is in the ineffective category. Even though Discovery-based Learning has the greatest N-Gain, when viewed from the effectiveness criteria, was seen as follows:

Table 4. Table of categories for interpreting the effectiveness of N-gain

Percentage	Interpretation
< 40	Ineffective
40-50	Less effective
56-75	Effective enough
>76	Effective

Source: Hake, R.R, 1999

So the class with the Discovery-based Learning model only reached the category of quite effective. However, this is better when compared to classes in Inquiry-Based Learning and conventional models which are ineffective criteria. More details are in the following table:

Table 5. Class Group N-Gain Recapitulation of Inquiry-Based Learning, Problem Based Learning, and Conventional Learning Models

Value Summary	**Class Group**		
	Inkuiri-Based Learning	Discovery-based Learning	Convensional
N-Gain	**27,00**	62,00	35,00
Category N-Average gain in percent	Ineffective	Effective enough	Ineffective

Based on the results of hypothesis testing, it was obtained data that there was no difference between learning outcomes in Inquiry-Based Learning, Discovery-based Learning and conventional models. Even so, when viewed from the N-Gain, class learning outcomes using Discovery-based Learning have a greater N-gain than classroom learning outcomes using Inquiry-Based Learning models and conventional models. However, the difference in N-gain is quite thin, making hypothesis testing provide information that there is no difference between the three. This means that the differences are not significant.

There are various factors that can cause no significant difference between each model. Among them is because these models both have good advantages or also have weaknesses. Inquiry-Based Learning is able to create new abilities in implementing ways of learning according to the talents of each student. These strengths can actually become weaknesses, because the process requires teachers or lecturers to be more creative in carrying out learning activities. Conditions in Indonesia where it is customary to fill college classes with as many students as possible, of course there will be difficulties in making learning that accommodates the talents of all students.

According to Legowo, (2017) an important key in designing lessons for Inquiry-Based Learning classes is to think about how we translate curriculum content into learning experiences that stimulate students' Inquiry-Based Learning profiles. So success in learning is very dependent on these keys. Whereas conventional learning, which refers to the lecture method with a little discussion, is inevitable about its shortcomings. However, students' familiarity with this model actually makes this model have advantages, namely students are able to adapt to their learning process.

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Meanwhile, Discovery-based Learning has advantages, one of which is developing critical thinking skills and increasing students' ability to adapt to new knowledge through problems presented by lecturers. However, the weakness arises when students do not have confidence that they are able to solve the problem being studied so that they are reluctant to try to solve the problem (Setiawan: 2018).

In the experimental class with the Inquiry-Based Learning model, students get a small N-Gain score of 27.00 and are in the ineffective category. In theory, this model should have a significant impact on the N-Gain of learning creativity. If this does not happen, then there may be causative factors that may occur to both students and lecturers. It could be that the class is not optimally explored for its intelligence because students are less active or not serious in following the lesson or filling out the questions. Even so errors or deficiencies can occur in the teacher. There may be missed or missing stages, and other possibilities. But what is certain is that there is no learning model that is truly suitable for all classes. Because each class has different students.

Legowo, (2017) suggests seven stages of learning based on Inquiry-Based Learning theory: (1) focusing on specific goals; (2) formulate key Inquiry-Based Learning questions; (3) consider the possibility of its application; (4) do a brainstorm; (5) selecting appropriate activities; (6) determine the sequence of activity plans; and (7) implement the plan. In this activity the teacher is required to understand the concept of Inquiry-Based Learning and have a variety of knowledge and skills about learning methods, as well as being creative. Misconceptions that occur in lecturers may result in these seven stages not going well. In addition, Armstrong (in Legowo, 2017) also provides an example of a learning guide for the Inquiry-Based Learning model called "*key materials and methods of Inkuiri-Based Learning teaching*".

This classifies the Inquiry-Based Learning learning framework into four dimensions, namely dimensions: (1) intelligence (eight intelligences); (2) learning activities; (3) teaching materials, and (4) learning strategies. So if these stages are not successfully carried out optimally then the possibility of non-optimal learning outcomes is very likely to occur. Or if this model is considered new by students, it is possible that they feel unfamiliar with the stages.

In the N-Gain experimental class, student learning outcomes are in the criteria of being quite effective. This means that the stages of learning in Discovery-based Learning with all its advantages and disadvantages have been able to make students have an adequate increase in learning achievement compared to before (pre-test). The findings of this study are in accordance with the findings of Nur, Pujiastuti and Rahman (Nur et al., 2016) that PBL has a significant effect on increasing learning creativity

Tyas, (2017) explained that the important point of discovery learning is in the application of problems that can encourage and direct the learning process. Discovery-based learning practices utilize small groups (7-10 people) guided by a facilitator. Discovery-based learning itself is based on constructivism theory which holds that learning is a process of self-building new knowledge and experiences based on students' prior knowledge. But even so, the presence of Discovery-based Learning which has been around for a long time and is often used by lecturers can have an impact on improving learning outcomes. So in this case, getting used to the application of certain models is very important to do.

For the control class that uses the conventional model, even though the N-Gain of learning creativity is in the less effective criteria, it is still better when compared to the class in the Inquiry-Based Learning experiment. A very strong factor causing this to happen is because students are used to this model so they can take part in learning in a relaxed manner even though the increase is not that great. It was mentioned earlier that Runco & Jaeger, (2012) stated "creativity requires both originality and effectiveness". So there is no change in student creativity because students are not used to generating new and original and effective ideas. So they prefer conventional learning compared to learning the Inquiry-Based Learning model.

Glaveanu, (2018) said in more detail "*I identify three prototypical ways of defining creativity. The first and most common one, continuing the legacy of the Renaissance and Romanticism, associates creativity with the arts and emphasizes self- expression, originality, and divergent thinking. The second one, related to the ideals of the Enlightenment, connects creativity with science and discovery and brings to the fore its functional, Discovery-based Learning aspects".*

Creativity is also associated with the ability to solve problems. Then the effectiveness in question is explained more about the ability of creativity in providing solutions to a problem. This could be the reason for the research findings which show that classes with the Discovery-based learning model gain higher effectiveness when compared to other classes. This finding also confirms that the creative side will emerge and develop when someone encounters a problem

4. CONCLUSION

Based on the results of hypothesis testing, it can be concluded that there is no difference in creativity with the use of Inquiry-Based Learning, Discovery-based Learning and conventional models. Even so, if we look at the N-Gain gain in each model, the largest model in a row is the Discovery-based Learning model with an N-Gain of 62. Followed by the N-gain of the conventional class, which is 35. Finally, the N-gain of the Inquiry class -Based Learning, by 27.

When viewed from the N-Gain criteria, the experimental class with the Inquiry-Based Learning model is included in the ineffective criteria. The experimental class with the Discovery-based Learning model is in the criteria of being quite effective while the control class with the conventional model is in the criteria of being less effective.

5. REFERENCES

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