UJMER 9 (2) 2020 139 – 146

Unnes Journal of Mathematics Education Research

http://journal.unnes.ac.id/sju/index.php/ujmer

# Mathematical Connection Ability Based on *Self-Efficacy* in IDEAL Problem Solving Model Assisted by ICT

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**Article Info**

Article History:
Received 28 June 2020
Approved 14 August 2020
Published 23 December 2020

Keywords:
Mathematical Connection,
Self-efficacy,
IDEAL Problem Solving,
ICT.

**Abstract**

Mathematical connection ability and self-efficacy are important for students possess in learning mathematics. A learning model is needed that can help students improve their mathematical connection ability and self-efficacy, namely IDEAL Problem Solving assisted by ICT. The research aims (1) to determine the quality of IDEAL Problem Solving assisted by ICT on students' mathematical connection ability and (2) to determine students' mathematical connection ability based on self-efficacy. The study used a mixed method with a quantitative first stage and continued qualitatively. The student population is students of class X SMA N 6 Semarang with two sample classes. The results showed that (1) IDEAL Problem Solving learning assisted by ICT is quality for students' mathematical connection ability; (2) students with high self-efficacy have mathematical connection ability in all four indicators, students with medium self-efficacy, almost have all indicators of mathematical connection ability but on indicators connecting mathematical concepts with daily life, students have not fulfilled these indicators well, while students with low self-efficacy do not yet have complete mathematical connection ability for all indicators.



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**p-ISSN 2252-6455**
**e-ISSN 2502-4507**

## INTRODUCTION

Every human activity, consciously or not, always has a connection with mathematics (Wardono et al, 2018). According to the National Council of Teachers of Mathematics (NCTM) (2000), there are five standards in the process of learning mathematics, one of which is connection. To carry out the role of mathematics, we need an ability to connect mathematical ideas to other sciences and to the social world. According to the National Council of Teachers of Mathematics (NCTM) (2000), there are five standards in the process of learning mathematics, one of which is connection.

Mathematical connection ability is the ability to connect mathematical concepts both between mathematical concepts and link mathematical concepts with other fields, which include connections between mathematical topics, connections with other sciences, and connections with everyday life (Dewi, 2013). The ability of mathematical connections is very important and is needed early for students, because connections are at the heart of mathematical definitions that can build mathematical understanding and look for representative relationships between concepts and procedures from different mathematical ideas and outside mathematics (NCTM, 2000; Mwakapenda, 2008; Mhlolo et al, 2012; Prastiwi et al, 2014; Mahendra & Mulyono, 2017). The relationship between mathematical contexts makes learning more meaningful because students can see real problems in learning and can solve them using mathematical concepts (Ainurrizqiyah et al, 2015; Putri & Santosa, 2015).

According to NCTM (2003) in Dinni & Isnarto (2018), students are said to have good mathematical connection skills if students can identify, use, and build connections between mathematical ideas in contexts outside mathematics as a mathematical understanding. In this study, indicators of mathematical connection ability used include: (1) connecting between mathematical concepts in a topic in mathematics, (2) connecting concepts between mathematical topics, (3) connecting mathematical concepts with other disciplines, and (4) connecting mathematical concepts with everyday life.

Although mathematics has benefits for daily life, there are still many students who think that mathematics is a difficult and frightening subject (Kuswidyanarko et al, 2017). Students' beliefes in their ability to face a challenge is often referred to as self-efficacy. According to Bandura (1994), self-efficacy is a person's beliefs about their ability to produce a determined level of performance affecting events that affect their lives. Self-efficacy is an assessment of students' abilities in determining beliefs and choices, striving for efforts to progress, persistence and perseverance in the face of difficulties, degrees of anxiety or calmness and maintaining tasks (Nadia et al, 2017; Sunaryo, 2017; Damaryanti et al, 2017; Taubah et al, 2018). Self-efficacy provides motivation to improve learning methods, learning achievement outcomes, and problem solving (Zimmerman, 2000; Motlagh et al., 2011; Martalyna et al, 2018).

The learning process undertaken by the teacher is very influential on the mathematical connection ability and self-efficacy of students, so we need a learning model that has coherent stages in solving problems so students can gradually connect mathematical concepts to solve problems and to increase self- efficacy students be better.

The learning model introduced by Bransford & Stein (1993) is one of the learning models that can help students solve problems because this model is carried out in detail and systematically (Nayazik et al., 2013; Siswanto et al., 2013). The stages of the learning model are I-Identify problems and opportunities; D-Define goals; E-Explore possible strategies; A-Anticipate outcomes and act; L-Look back and Learn. The learning model is known as IDEAL Problem Solving.

Nowadays, technological progress is growing rapidly. The use of ICT in the implementation of learning is expected to make learning goals can be achieved more easily and effectively for students. According to Yohannes *et al*. (2016), learning to use ICT in multimedia is more effective than learning using conventional methods. Learning with the use of ICT will provide maximum benefits to students in accordance with the times in the era of high ICT use by using the internet (Wardono et al., 2018). Such learning systems are often referred to as e-learning. One of the learning platform that is widely used by

schools in Indonesia is the Modular Object-Oriented Dynamic Learning Environment (Moodle). According to Handayanto (2018), Moodle-based learning can increase student interest, participation, and learning outcomes.

Based on these descriptions, the research's formulation problems are (1) how is the quality of learning IDEAL Problem Solving assisted by ICT on students' mathematical connection ability?; (2) how is the students' mathematical connection ability based on self-efficacy?

## METHOD

The research method used was mixed method that combines quantitative and qualitative research. In the first stage, quantitative data was collected and analyzed, then followed by the collection and analysis of qualitative data, which was built on the initial results of quantitative data.

The study was conducted in Senior High School 6 Semarang in grade X even semester 2018/2019. The population students from grade X and the research sample was two class from grade X. The research subjects were selected based on the results of the self-efficacy questionnaire which was classified into high, medium, and low groups. Each group was selected two students as a research subject. For research subjects in the high self-efficacy group were selected two students who had the highest questionnaire scores and the lowest questionnaire scores in this group, research subjects in the medium self-efficacy group were selected two students who had the highest questionnaire scores and the lowest questionnaire scores in this group, and research subjects in the low self-efficacy group were selected one student who had the highest questionnaire scores and the lowest questionnaire scores in this group.

Quantitative data were obtained from the results of the Mathematical Connection Ability Test (MCAT) twice, namely the initial test (pretest) and final test (posttest) with the same weight and indicators. While qualitative data were obtained through observation, questionnaires, and interviews.

The quality of learning in this study includes the planning, implementation, and evaluation stages. In the planning stage, it is said to be of quality if the learning tools and research instruments are tested for validity by obtaining the minimum good criteria. At the implementation stage, it is said to be of quality if the results of the assessment of the implementation of learning is minimal good. The evaluation stage, learning is said to be of high quality if the positive response of students reaches more than or equal to 70%, the average MCAT gets more grades than the minimum completeness criteria, the mathematical connection ability of students reaches a classical completeness, and the average MCAT student in learning IDEAL Problem Solving assisted by ICT is better than and the average MCAT students in Discovery Learning

## RESULT AND DISCUSSION

The quality of learning includes the planning, implementation, and evaluation stages. Evaluation of the quality of learning IDEAL Problem Solving assisted by ICT, at the planning stage a validation test was conducted on the learning tools and assessment instruments. Table 1 below shows the results of the validation of learning tools and research instruments.

**Table 1.** The Results of The Validation of Learning Tools and Research Instruments

| Learning Tools and Research Instruments | Score | Classification |
|---|---|---|
| Syllabus | 4.65 | Very good |
| Lesson Plan | 4.6 | Very good |
| Student Worksheet | 4.475 | Very good |
| Content Validation of MCAT | 4.72 | Very good |
| Construck Validation of MCAT | 4.84 | Very good |

Based on Table 1, obtained the fact that the results of the validation of learning tools and research instruments used get an average grade that was very good, so the learning planning stage was said to be of good quality.

In the implementation stage, learning is said to be of quality if the assessment of learning implementation gets a minimum good score. This

assessment uses a 5 scale rating scale, which is filled by an observer. The observer who assesses was a teacher in the research school. There were five times the learning with the acquisition of scores that will be presented in Table 2.

**Table 2.** Learning Implementation Results

| Meetings | Score | Classification |
|---|---|---|
| 1 | 4.91 | Very good |
| 2 | 4.3 | Very good |
| 3 | 4.6 | Very good |
| 4 | 4.78 | Very good |
| 5 | 4.83 | Very good |

Based on Table 2, the scores for each meeting get a very good classification. The average score of the implementation of learning obtained was 4.68 with very good classification. From these results it can be concluded that the implementation stage is to be quality.

At the evaluation stage, students' responses to the learning questionnaire were analyzed. The score obtained from the student's questionnaire responses to IDEAL Problem Solving Learning assisted by ICT was 88.4%. Based on the results of the questionnaire, the positive responses were given by students, reached more than or equal to 70%. So, the quality of learning in terms of student responses is said to be quality.

Then in the evaluation stage, quantitative MCAT results were analyzed. Before making data analysis, it was necessary to give prerequisite tests on the initial data for the experimental class and the control class in the form of normality tests, homogeneity tests, and average difference tests. In the normality test, using the Kolmogorov-Smirnov test and obtained a sig value = 0.2> 5%, meaning that Ho was accepted. So, the sample was from a normally distributed population. In the homogeneity test, using the Levene Test in the SPSS program and obtained a sig value = 0.871> 5%, meaning that Ho was accepted. So, population variance was homogeneous. In the average difference test, using the Independent Sample t-test SPSS program and obtained sig values (2-tailed) = 0.652> 5%, meaning that Ho was accepted. So, the average mathematical connection ability of students in the two samples did not differ significantly. Based on the results of these prerequisite tests, it can be concluded that the experimental class and the control class have no significant different initial conditions.

The first quantitative data test was the average test. The minimum completeness criteria value used was 70. The following table 3 presents the results of the average test calculation.

**Table 3.** Average Test Calculation Results

| Average ($\bar{x}$) | $t$ | $t_{(1-\alpha),dk}$ | Criteria |
|---|---|---|---|
| 75,9 | 2,052 | 1,697 | Reject Ho if $t > t_{(1-\alpha),dk}$ |

Based on the results of calculations, the value of t is 2.052. For α = 5% and dk 35, the value of t (0.95) 35 is 1.697. Because 2.052> 1.697, then t> t (1-α), dk, meaning Ho is rejected and $H_1$ is accepted. So, the average mathematical connection ability of students in learning IDEAL Solved Problem Solving by assisted ICT is more than minimum completeness criteria.

The second quantitative data test was the classical completeness test. Learning is said to be classically complete if the proportion of students achieving completeness is more than or equal to 75%. Table 4, presents the results of classical completeness test calculations.

**Table 4.** Classical Completion Test Calculation Results

| $(x)$ | $z$ | $z_{(0,5-\alpha)}$ | Criteria |
|---|---|---|---|
| 22 | $-1,92$ | 1,64 | Reject Ho if $z \geq z_{(0,5-\alpha)}$ |

Obtained z = -1.92 < 1.64 = $z_{(0,5-\alpha)}$ , meaning that Ho is accepted. Thus, the proportion of experimental class students who achieved completeness was less than or equal to 75%. Because $H_0$ is accepted, there are two possibilities for π, namely π = 75% or π <75%. Therefore, it is necessary to do further tests using a two-part proportion test. To find out whether the proportion of students completeness in the experimental class has reached 75% or not. In further tests, the results obtained are presented in Table 5.

**Table 5.** Classical Completion Completion Test Results

| $(x)$ | $z_{hitung}$ | $z_{\frac{1}{2}(1-\alpha)}$ | Criteria |
|---|---|---|---|
| 22 | −1,92 | 1,96 | Reject Ho if $-z_{\frac{1}{2}(1-\alpha)} < z_{hitung} < z_{\frac{1}{2}(1-\alpha)}$ |

Obtained $-1{,}96 < -1{,}92 < 1{,}96 \Leftrightarrow -z_{\frac{1}{2}(1-\alpha)} < z_{hitung} < z_{\frac{1}{2}(1-\alpha)}$, , meaning that Ho is accepted. The proportion of experimental class students who achieved completeness was equal to 75%, meaning that there were 75% of the total number of experimental class students scored more than or equal to 70. So, the students' mathematical connection ability in IDEAL Problem Solving assisted by ICT learning was classically complete.

In the average difference test, the value of t is 2.83, while the t table value is 2.83. so, $2{,}83 > 1{,}67 \Leftrightarrow 1t_{hitung} > t_{(1-\alpha)}$, meaning Ho is rejected. So, the average students' mathematical connection ability in the experimental class is more than the average mathematical connection ability of students in the control class.

The next step is a qualitative analysis of students' mathematical connection ability based on sef-efficacy. Students in the experimental class were given a self-efficacy questionnaire to group students into high, medium, and low self-efficacy groups. Following are the results of the self-efficacy questionnaire of 36 students presented in Table 6.

**Table 6.** Self-Efficacy Grouping Results.

| Group | Number of Students |
|---|---|
| High | 8 |
| Medium | 21 |
| Low | 7 |

The results of the mathematical connection ability test scores based on self-efficacy are presented in Figure 1.

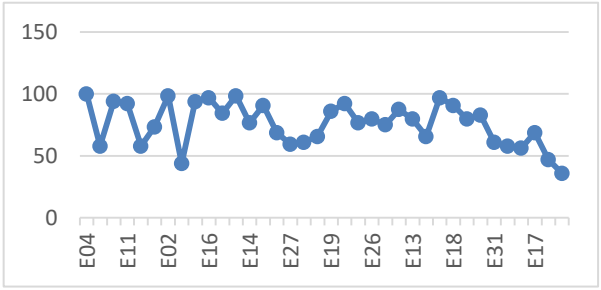


**Figure 1**. Graph of Test Results for Mathematical Connection Ability

Figure 1 shows that the mathematics connection ability test scores based on self-efficacy are varies. In the high self-efficacy group, there are 8 students with 5 of them getting minimum completeness criteria. The research subject with the highest self-efficacy score in this group is E04 which has a perfect mathematical connection ability test score of 100, meaning that E04 has mathematical connection ability in all indicators. The research subject with the lowest self-efficacy score in this group is E02 which has a mathematical connection ability test score of 98. There is an inaccuracy in calculating the formulas with indicator 4, namely connecting mathematical concepts to everyday life. It affects the wrong answers. Although the value obtained is not perfect 100, but E02 has mathematical connection ability in all indicators.

In the medium self-efficacy group, there are 21 students with 15 of them getting the minimum completeness criteria. The research subject with the highest self-efficacy score in this group is E35 which has a mathematical connection ability test score of 94. E35 cannot find the correct results of the problem in indicator 1 (connecting between mathematical concepts in a mathematical topic) because there is an error in the use of problem solving strategies. Even though E35 cannot solve problems with correct results, but E35 can determine problem solving strategies by connecting between mathematical concepts in a mathematical topic, so that E35 has mathematical connection ability in all indicators. For the research subjects with the lowest self-efficacy score in this group is E30 which has a mathematical connection ability test score of 80. E30 cannot solve the questions on indicator 4 well (connecting mathematical concepts with everyday life). E30 does

not understand the problem given, so E30 does not know how to solve the problem. However, E30 has mathematical connection capabilities for indicator 1 (connecting between mathematical concepts in a mathematical topic), indicator 2 (connecting concepts between mathematical topics), and indicator 3 (connecting mathematical concepts with other disciplines).

In the low self-efficacy group, there are 7 students with only 1 student who has the minimum completeness criteria. The research subject with the highest self-efficacy score in this group is E23 which has a complete mathematical connection ability test score, which is 83. E23 cannot find the correct results of the questions on indicator 1 (connecting between mathematical concepts in a mathematical topic) because there are errors in determine problem solving strategies, as well as questions on indicator 2 (connecting concepts between mathematical topics), due to a lack of accuracy in calculating arithmetic operations. Although E23 cannot solve problems with correct results, E23 can understand problems and determine problem solving strategies by connecting mathematical concepts in a mathematical topic or connecting concepts between mathematical topics. The research subject with the lowest self-efficacy score in this group is E22 which has the lowest mathematical connection ability test in its class, which is 36. E22 only writes the results of work on indicator 1 (connecting between mathematical concepts in a mathematical topic) and indicator 2 (connecting concepts between mathematical topics). However, the results of the work written also do not show any interrelation between concepts in problem solving because E22 only wrote down what information was known and asked of the problem, and a formula that was not in accordance with problem solving. So, E22 does not have mathematical connection ability in all indicators. During the interview, student claimed to dislike questions in the form of stories and felt confused when faced with such questions. If he already feels confused, he will be discouraged and not interested in working on the problem. It appears that students do not have the enthusiasm or desire to try to work on the problem given. This is in line with the opinion of Liu & Koirala (2009), that self-efficacy has a positive influence on mathematics achievement. If students do not have good self-efficacy, students will feel doubt in using mathematical concepts to be applied to other mathematical concepts as well as concepts outside of mathematics. Students do not have the determination and enthusiasm to try to solve problems.

## CONCLUSION

Based on the results of the study and discussion, it is concluded that (1) IDEAL Problem Solving learning assisted by ICT is to be quality for students' mathematical connection ability, (2) the results of mathematical connection ability based on self-efficacy are varies, students with high self-efficacy have mathematical connection ability on the four indicators namely connecting mathematical concepts in a topic in mathematics, connecting concepts between mathematical topics, connecting mathematical concepts with other disciplines, and connecting mathematical concepts with everyday life; students with medium self-efficacy have almost mathematical connection skills on all four indicators but on indicators connecting mathematical concepts with daily life, students have not fulfilled these indicators well. Students with low self-efficacy do not yet have complete mathematical connection ability for all indicators.

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