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The effectiveness of IDEA learning model in mathematics concept understanding

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ABSTRACT

This research aimed to determine the effectiveness of the issue, discussion, establishment, and application (IDEA) learning model in embedding mathematical concepts understanding. It is a quantitative study with a quasi-experimental approach. This research was conducted at Malang Islamic University with students majoring Mathematics education study program and in their first academic year as the subjects. Subjects were divided into two group, experimental and control and measured their result using posttest only control group design. There are six instruments consisting six items used to measure mathematical concepts understanding. The results confirmed that H_0 is rejected, while H_a is accepted proved by t count (3.132)>t_{table} (1.674). It means there is a significant difference between the of both groups (experimental and control). In addition, the results indicated that the IDEA learning models is effective to assist students in understanding mathematical concepts showed by the higher score of experimental groups than control group. Three factors are involved in order to implement the IDEA learning model effectively; namely: individual problem-solving opportunities, active student involvement, and guidance and assistance (from lecturer) on the IDEA learning model. This research is only limited to preservice teacher, further research is required in order to implement this model for mathematics learning at junior and senior high schools' level.

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1. INTRODUCTION

Understanding concepts in mathematics learning becomes concern of mathematics teachers and lecturers. This is because mathematical concepts are used to solve problems in real life [1]; for examples, the concepts of distance between two points representing the real distance of two cities/areas. In addition, it is important as it becomes the basis to understand procedural knowledge [2]–[5] as well as other related concepts [5]–[7], such as the Pythagorean concept which is used to determine the distance of two points. This leads to indication that students who are successful in solving trigonometric problems have a good understanding of concepts vice versa [4]. Therefore, understanding concepts in mathematics learning is important for students as it assists them to successfully solve mathematic problems.

However, many researches indicate that many mathematics students experience misconceptions [8]–[14]. This is mainly due to their low understanding in mathematical concepts. One of factors influencing this conditions is the lecturers' competence during the classroom delivering as found by Setiawan [15] on the effect of teacher competence on classroom learning and students achievement. It means that students experience misconceptions because of no mathematical concepts understand studied [8]. In addition, Previous researchers [16], [17] found that teachers/lecturers difficulties in teaching mathematical concepts are due to unavailability of appropriate mathematical concepts learning model or teaching materials. Hence, these misconceptions were caused by their (students) low understanding on mathematical concepts and the inappropriate learning models on mathematical concepts during classroom activity. So, in order to improve/strengthen students understanding on mathematical concepts, good learning model is highly required.

One of the ways to improve classroom learning is by developing an appropriate learning model that are able to improve students understanding of mathematical concepts. The issue, discussion, establishment, and application (IDEA) learning model is one that highly suggested [5], [6], [18]. This learning model is defined as a plan used in designing learning materials and assisting classroom learning based on four activities, namely finding issues/problems, carrying out group discussion, drawing conclusion on concepts used (establishment concepts), and applying it to solve problems [18]. First activity is finding issue (Issue); in this activity, students state the problems/issues found and their opinion related to them. Followed the second activity is to engage in discussion. During this group discussion, students need to present their ideas (individually) about the problems/issues found and discuss with the groups to simplify the problems (finding the easiest/simplest solution). Third activity is to establish the concept. In this activity, students have to draw conclusion (based on discussion) on the best concept used to solve the problems by changing the abstract ideas into tangible one that can be solved. Lastly is the fourth activity; in this one, students apply the concepts found [19]. By implementing these activities, students can finally have clear understanding on mathematical concepts to solve mathematics problems [20], [21]. Accordingly, the IDEA learning model has been found as appropriate learning model to improve students understanding on concepts in mathematics learning.

Previous research found that the IDEA learning model is relevant addressing students' needs to develop an understanding on mathematical concepts by 84.73% and teachers' needs by 74.17% which means that this learning model is valid to improve an understanding on mathematical concepts [5]. This condition achieved is because the IDEA learning model has all requirements of a good learning model, is oriented towards concepts understanding, and contains indicators of concepts understanding at each stage of its learning [5]. In addition, Setiawan and Mustangin [6] mentioned that the IDEA learning model is practically suitable for mathematics learning as it is simple, timely, effortless, and cost-effective, meaning that the IDEA learning model meets the relevance, validity, and practicality of a learning model.

However, despite meeting relevance, validity, and practicality, a learning model should be effective as well [22]–[26], as it can define a success [19]. A success of learning model in achieving the objectives by showing its effectiveness. As previous researches only found the relevance, validity, and practicality of the IDEA learning model in embedding mathematical concepts understanding, further research is required. Therefore, this research aims to determine the effectiveness of the IDEA learning model in embedding mathematical concepts understanding. Theoretically, this research benefits to assist the mathematical concepts understanding using the IDEA learning model by showing its effectivity. Meanwhile, practically, this research benefits to mathematics teaching-learning activity, especially teachers/lecturers by proving the effectiveness of the IDEA learning model to embed concepts understanding in mathematics learning.

2. RESEARCH METHOD

This research was conducted at Malang Islamic University. The subjects were students who are in the first year of their academic year (2020/2021) and majoring Mathematics education study program. After conducting homogeneity and normality tests, two classes were selected as research subject. These classes, then, divided into experimental and control group. This research is quasi-experimental research with IDEA learning model as independent variable and mathematical concepts understanding as dependent variable. This research employs posttest only control group design as shown in Table 1.

Table 1. Research design

Group	Treatment	Posttest
E	X	O
C	Y	O

E = Experiment group;
C = Control group;
X = IDEA learning model;
Y = conventional learning model
O = post-test score of both experiment and control group

Quantitative data in this research are obtained from the pretest and posttest results on mathematical concepts understanding tests on selected subjects. The pretest and posttest were carried out by giving questions consisting of six items in the trigonometry course to test mathematical concepts understanding on both groups (experimental and control). Posttest was delivered to both groups after the experimental group received treatment/intervention using the IDEA learning model (four meetings) and control group conducted class as usual (using conventional learning).

According to data collection technique, the research instruments six pretest and posttest questions on mathematical concepts understanding were developed by the researcher in form of descriptions questions. These aim to identify all indicators sets to understand students' mathematical concepts through problem solving steps. There are six indicators in the two tests (pretest and posttest), namely: i) Ability to express concepts in own language; ii) Ability to classify objects according to mathematical concepts; iii) Ability to provide examples and non-examples; iv) Ability to present various ways of concepts understanding; v) Ability to relate concepts one another; and vi) Ability to implement concepts in problem solving [7], [20], [21]. Each instrument was tested for its validity and reliability before being used (both pretest and posttest) [27]. In addition, it was tested for its difficulty level and difference power in order to meet the standard set [28], [29]. After the instruments are proved for their validity, reliability, difficulty level, as well as difference power, they were used in both pretest and posttest. Data collected from pretest were tested to determine their normality and homogeneity, because in order to conducted the research, the data obtained have to be normally distributed and homogeny [27]. The normality test and homogeneity test were performed using statistical product and service solution (SPSS) 19.

Accordingly, posttest data were analyzed using the independent sample t-test because the samples are mutually independent. Independent sample t-test was conducted by testing the difference in the average posttest score of the experimental and control groups. This test was performed in order to prove the hypotheses ($H_0: \bar{x}_1 = \bar{x}_2$, meaning that there is no difference of average score on both groups and $H_a: \bar{x}_1 \neq \bar{x}_2$, meaning that there is difference on the average score on both groups). These results are obtained based on t_{count} and t_{table}. Thus, when $t_{count} > t_{table}$, H_0 is rejected and H_a is accepted, meaning that there is a difference on the average score of both groups. If the average score of experimental class is higher than the control class, it shows that the IDEA learning model is effective in instilling mathematical concepts understanding on students in Mathematics learning.

3. RESULTS AND DISCUSSION

The results are presented respectively. First is the validity, reliability, difficulty level, and difference power of the instruments; followed by the normality and homogeneity test. Lastly, the hypothetical test was conducted on both groups to determine the results.

3.1. Results of validity, reliability, difficulty levels, and instrument distinction testing

The first step in this research was to design a research instrument (questions used in both pretest and posttest). The instruments consist of six items (in descriptive questions). Before implemented (in both pretest and posttest), the validity, reliability, difficulty level, and difference power of each instrument. The validity and reliability test were performed by using the product moment validity test of SPSS 19 to subjects selected (27 students), meaning that r_{table} *at* d=(N-2)=27-2=25 with the significance of 5% (on two-way test), accordingly d=25 is 0.381. If r_{count} is higher than r_{table}, instrument considered as valid and possible to be implemented. Table 2 shows that all instruments (both pretest and posttest) have r_{count} higher than r_{table}, meaning that all questions are valid. While for reliability test, the Alpha Cronbach of SPSS 19 was performed on all instruments (pretest and posttest). The result of the Alpha Cronbach on pretest is 0.731 meaning that it is higher than r_{table} (0.381); thus, all pretest instruments are reliable. Meanwhile, the *Alpha Cronbach* on posttest is 0.592 meaning that it is higher than r_{table} (0.381); thus, all posttest instruments are reliable as presented in Table 3.

Table 2. Result of validity test on pretest and posttest

	Pretest			Posttest		
No.	r_{count}	r_{table}	Interpretation	r_{count}	r_{table}	Interpretation
1	0.826	0.381	Valid	0.602	0.381	Valid
2	0.464	0.381	Valid	0.623	0.381	Valid
3	0.724	0.381	Valid	0.525	0.381	Valid
4	0.833	0.381	Valid	0.475	0.381	Valid
5	0.779	0.381	Valid	0.719	0.381	Valid
6	0.443	0.381	Valid	0.498	0.381	Valid

Table 3 shows that all instruments (both pretest and posttest) have r_{count} higher than r_{table}, meaning that all questions are reliable. For level of difficulty test, researchers employ the Mean test based on the average score of both pretest and posttest scores. The question considers as difficult if it scores lower than the average score (*x<0.3*); medium if it scores between 0.3 and 0.7 (*0.3>x> 0.7*); and easy if it scores more than 0.7 (*x>0.7*). Table 4 shows that instruments on both pretest and posttest have both easy and medium level of difficulty. In the difference power test, Product Moment test of SPSS 19 is employed with criteria (good and excellent) according to Gufron and Sutama [29]. Table 5 reveals that the difference power test results score 0.71 to 1.00, it considers as excellent; and if it scores 0.41 to 0.70, it considers as good.

Table 3. Result of reliability test on pretest and posttest

	Pretest			Posttest		
No.	Alpha	r_{table}	Interpretation	Alpha	r_{table}	Interpretation
1	0.625	0.381	Reliable	0.533	0.381	Reliable
2	0.743	0.381	Reliable	0.524	0.381	Reliable
3	0.701	0.381	Reliable	0.572	0.381	Reliable
4	0.626	0.381	Reliable	0.592	0.381	Reliable
5	0.645	0.381	Reliable	0.457	0.381	Reliable
6	0.791	0.381	Reliable	0.588	0.381	Reliable

Table 4. Result of level of difficulties on pretest and posttest

	Pretest		Posttest	
No.	Mean	Interpretation	Mean	Interpretation
1	7.56	Easy	7.74	Easy
2	7.19	Easy	7.93	Easy
3	5.00	Medium	6.93	Medium
4	7.59	Easy	7.15	Easy
5	7.56	Easy	7.04	Medium
6	8.26	Easy	7.44	Easy

Table 5 shows that instruments on both pretest and posttest have differentiation strength as good or excellent, so they possibly differentiate the student's ability (low, medium, and high). From the analysis, the validity, reliability, level of difficulty, and difference power of instruments are proved. Therefore, the pretest instruments are possibly used to determine the initial ability of mathematical concepts understanding of students (both groups). Similarly for the posttest instruments, they are possibly used to determine mathematical concepts understanding of students on experimental group (after implementing IDEA learning model) and control group (after implementing conventional learning model).

Table 5. Result of the difference power test on pretest and posttest

	Pretest		Posttest	
No.	r_{count}	Interpretation	r_{xy}	Interpretation
1	0.826	Excellent	0.602	Good
2	0.464	Good	0.623	Good
3	0.724	Excellent	0.525	Good
4	0.833	Excellent	0.475	Good
5	0.779	Excellent	0.719	Excellent
6	0.443	Good	0.498	Good

3.2. Result of normality and homogeneity test

After proved for their validity, reliability, difficulty level, and difference power, the following step was divided the subjects (students majoring Mathematics education study program) into two groups (A and B) and asked them to solve problems (pretest questions). The answers are, then, used in the normality and homogeneity tests. Table 6 presents the Shapiro Wilk test with a significance level of 5% was employed in the normality test for all subjects (both groups).

Based on the normality test, the Sig. A is 0.207, while Sig. B is 0.382. As both Sig. are higher than 0.05 (>0.05), the data of both groups consider as normally distributed (see Table 6). Meanwhile, Table 7 shows the one-way ANOVA test using Compare Means was employed in order to determine the homogeneity of population.

Table 6. Results of normality test

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistics	df	Sig.	Statistics	df	Sig.
Pretest	Group A	.108	28	.200*	.951	28	.207
	Group B	.127	27	.200*	.961	27	.382

a. Lilliefors Significance Correction
*. This is a lower bound of the true significance

Table 7. Results of homogeneity of variances test

Levene Statistic	df1	df2	Sig.
.076	1	53	.784

Based on the homogeneity test, the Sig. on pretest of both groups are 0.78 (Sig.>0.05); meaning that the results are homogeny. As the results met both normality and homogeneity test, both groups (A and B) are possibly served as experimental and control group.

3.3. Result of hypothetical test

After the data are proved being normally distributed and homogenic, the last step was implemented, by dividing groups into experimental group (group A) who were given the IDEA learning model as intervention and control group (group B) who had conventional learning model. The intervention (implementing the IDEA learning model) was carried out in 4 meetings (using the IDEA learning model-based student worksheets) in the experimental group and 4 meetings (using conventional learning model-based student worksheets) in the control group. Apart from students' worksheets, teaching-learning activities (through online) explained the materials as well. After completing the learning process in 4 meetings. On the three meetings (first to third), the discussions are about the graphs of sin and cos as well as sec and cosec functions. The last meeting (fourth) was posttest. The results (posttest) are used in hypothetical test. This test aims to determine the effectiveness of the IDEA learning model in instilling mathematical concepts understanding by using independent sample t-test in order to find out whether each sample is independent (having no relation of one another) as presented in Table 8 and Table 9.

Table 8. Group statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Posttest	Experiment	28	76.25	17.558	3.318
	Control	27	61.63	17.043	3.280

Table 9. Results of independent sample test

		Levene Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Posttest	Equal variances assumed	.294	.590	3.132	53	.003	14.620	4.668	5.257	23.984
	Equal variances not assumed			3.134	52.997	.003	14.620	4.666	5.262	23.978

From Table 8, it is seen that the learning average for the experimental class is 76.25, while the control class is 61.63. Thus, statistically, it can be concluded that there is a difference of both groups (on their average scores). Moreover, the result shows that the experimental group has higher average score than the control group.

The significance of the difference in the average score (on experimental and control groups) is showed in Table 9. The Sig. Levene test for equality of variances is 0.590, meaning that it is higher than 0.05 (0.590>0.05), it indicates that both groups are homogeneous. Hence, the independent sample t-test referred to the Equal variances. As the t_{count} is 3.132 with df of 53 and the significance 5% as well as t_{table} as 1.674, the relationship of t_{count} and t_{table} is that tcount is higher than t_{table} (3.132>1.674). Therefore, the finals mean as H_0 is rejected and H_a is accepted. This indicates that there is significant difference between the mean mathematical concept understanding test of both groups (experimental and control group). Because the average score of experimental groups is higher than control group, it means that the IDEA learning model is effective to improve students' concepts understanding in mathematics learning.

3.4. Discussion

Results of the research on the IDEA learning model significantly influence in improving concept understanding in Mathematics learning. From data analysis, the IDEA learning model provably shows its effectiveness in assisting students to understand mathematical concepts compared to conventional learning model. This is seen the average score of both groups (experimental and control) in which its $t_{count}>t_{table}$ (3.132>1.674). Moreover, three factors cause the IDEA learning model affectively improving concepts understanding in Mathematics learning.

First is the opportunities given to students to solve problems individually. This opportunity helps students to engage in problem solving considering individual opinion. This is supported by previous research on the influence of students learning outcomes to their involvement in constructing individual ideas to solve problems during study [30]. Moreover, this is in line with Santrock theory who mentions that when a person constructs his or her knowledge independently, one adapts to the knowledge he already has, thus meaningful learning occurs [30]. These results support the previous research which shows that simplifying problems (issues) into a simple one, so it can be easily solved. generating ideas can be done by providing simple problems (issues), namely problems that can be easily solved by students.

Second is the active student's involvement in the IDEA learning model. Previous researches indicate that student involvement in learning enables students to have better understanding on the concepts studied [31]. The learning involvement is seen during the discussion engagement. In the discussion, students present their ideas on how to solve problems given and find out the simplest method to solve based on the discussion. The presentations addressed the stages on the IDEA learning model, namely addressing issue (problem), conducting discussion, establishing method (drawing conclusion), and applying the concluded method. After presentation, there will be groups discussion which allow others to state/explain their opinions/idea before drawing conclusion (establishment) which means that through lecturer assistance, students select the simplest method to solve the problems/issues and this ensures the learning activeness. This process is in line with the previous research which indicates that collaborative learning models can be effectively developing creative thinking skills [32] and critical thinking skills [33], [34]. Thus, the active student involvement (in group study/discussion) certainly improve students' understanding on concepts in mathematics learning.

Third factor is lecturer/teacher guidance or assistance during learning activity. Lecturer provides assistance to students especially in understanding the IDEA learning model, such as what they should do on each step. This result is similar to previous studies on the IDEA learning model especially in term of students difficulties in implementing the learning model [6]. Therefore, the last factor affecting the success in implementing the IDEA learning model is teacher/lecturer guidance.

4. CONCLUSION

The research confirmed that the IDEA learning model is provably effective in embedding the mathematical concepts understanding of students. This indicates that implementing the IDEA learning model on students significantly improves students understanding on concepts in mathematics learning. In addition, three factors are involved in order to implement the IDEA learning model effectively; namely: i) Individual problem solving opportunities; ii) Active student involvement; and iii) Guidance and assistance (from lecturer) on the IDEA learning model. Furthermore, further research is required in order to implement this model for mathematics learning at junior and senior high schools level.

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