The Effect of Jigsaw Cooperative Learning Models with Assisted Augmented Reality (AR) on Mathematics Understanding Concept Ability

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Abstract

The objective of this study was to know if there is an effect of augmented reality (AR)-supported cooperative learning jigsaw on students' ability to understand concepts. Quantitative design with a single post-test was the method used in this study. The study tool is a descriptive test with 5-item questions and 2-item questions for each indicator. The tool was validated by expert instructors and expert teachers after the tool was validated and then tested on 81 students. Testing this device using a Rasch model, Cronbach's Alpha (KR-20) with score is 0.77. After the instrument is declared valid and reliable, it is further tested in the experimental class and the control class. Based on data analysis using Cohen's d, The Cohens test showed a significant effect of AR-assisted jigsaw learning on the ability to understand concepts with d = 1.28 meaning very high (ES > 1.2). It can be concluded that with AR-supported jigsaw learning, the ability to understand concepts has increased significantly compared to conventional learning.

Keywords: augmented reality, jigsaw, mathematical understanding concept

Introduction

The ability to understand mathematics is, among other things, mathematical knowledge that should be obtained by demonstrating an understanding of learned mathematical concepts, explaining the relationship between the content and using practical or algorithmic techniques to be accurate, efficient and precise solve problems (Komarudin et al., 2021). According to the Decree No. 21 of the ability to understand math is a skill that students must accept, Ministry of Education and Culture 2016. Indeed, students who better understand mathematical concepts are more likely to mathematics understanding concept ability (MUCA) (Mendikbud, 2016). The skill of conceptual understanding requires students to apply their knowledge to explain concepts that are easier to understand and apply (Fajar et al., 2019).

According to the PISA 2018 Results (Volume II), in 2018, MUCA skills of Indonesian students were ranked 73rd out of 79 countries included in this study. A recent study by (Fajar et al., 2019; Suryadi et al., 2021) shows that several factors influence students' lack of understanding of conceptual skills, including lack of motivation to learn, materialism, lack of understanding and failure to apply them appropriately learning methods. Then, some students simply attempt to memorize formulas and do not know how to effectively study. To make students effective in learning, an innovative learning model such as the jigsaw cooperative type is needed (Cochon Drouet, 2023).

Jigsaw is a form of collaborative learning in which several group members are responsible for mastering a particular portion of the learning material and can teach that portion to other members of the group (Walker & Crogan, 1998). This learning style breaks down the knowledge of a book or chapter into smaller, more manageable chunks (Garcia. et

al., 2017). According to (Subiyantari & Muslim, 2019) the advantages of the jigsaw learning model include the fact that students can rely on expert and original groups to achieve success in learning. In another opinion, the jigsaw method is one of the techniques that can be used in collaborative learning to help students work together and promote collaboration by eliminating competition within the class (Karacop, 2017). The utilization of technology in learning can aid in resolving learning problems, in addition to instructional models that enhance the understanding of concepts.

As technology advances, exciting learning reduces anxiety while increasing user motivation and learning success, thanks to the very rapid technological advancements in Augmented reality (AR) technology provides an exciting visual experience and visualization of concepts and abstract environments that can be created. AR combines the virtual and real worlds, including the entire experience in which virtual reality is simulated, adding virtual objects such as images, holograms, and video clips to the seem real (Chen, 2019; Hsiao et al., 2016). Student's ability to understand mathematical concepts can be improved and demonstrated in research using AR technology (Chen, 2019). The study conducted by (Del Cerro Velázquez & Méndez, 2021) found that the utilization of AR can enhance students' ability to understand concepts mathematics.

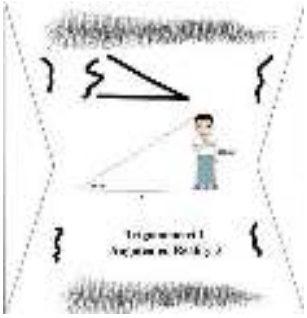

Figure 1. Augmented Reality

Relevant studies related to this research include first, (Yulianty, 2019) A study discussing MUCA, where the application of a real mathematical approach has a positive effect on students MUCA. Secondly, this study (Wahyuni & Rahmiati, 2022) examined Jigsaw cooperative learning models revealed that the math learning outcomes of students using the Jigsaw collaborative learning increased significantly compared to those using conventional models. Third (Heryekti, 2021) The Jigsaw cooperative model study found that using the Jigsaw cooperative learning method improved students' average post-test scores compared to pre-test scores before using the Jigsaw method.. Finally, a study (Oktaviani et al., 2020) know the effect of AR and found that the use of AR can improve student understanding, as evidenced by improved learning in testing after using augmented reality media.

Based on previous research, there is still limited research that has utilized AR in the jigsaw model to MUCA. The novelty of this study is the utilization of AR media in mathematics learning using the cooperative learning technique, jigsaw. The purpose of this research to delve the effect of the AR-assisted jigsaw cooperative models on students MUCA.

Method (Times New Roman, 13, Bold)

A one-group posttest-only design was the research methodology used in this study for carry out study and conclude the research (post-test) (Arikunto, 2015). In this research design, two randomly selected sample classes were used, namely the experimental and control classes. Both classes were given treatment, and at the end, a posttest was

administered to measure the students' MUCA. During the treatment phase, the AR-assisted jigsaw cooperative learning model will be used in the experimental class, while the conventional model used by the school's teacher will be applied in the control class.

Table 1. Design Research.

Group	Treatment	Post-test
Experiment	X_j	O_1
Control		O_2

Explanation:
X_j: the use of cooperative learning model with jigsaw technique
O_1: post-test given to the experimental group after treatment.
O_2: post-test given to the control group after treatment.

Table 1 show this study uses a random class selection technique based on existing classes in the population. The cluster random sampling technique randomly selected 8 classes, and 2 classes were selected randomly, which resulted in class X-4 as the experimental class and class X-8 as the control class. In this study, a test consisting of 5 items was used as an instrument to assess students' MUCA and trigonometry. There are two validators for validating this tool: a math educator and a math teacher.

Perform device validation after the device has been declared viable by a validator. Analyze study validity using the Rasch model method. Validity and reliability tests were conducted using the Winsteps software. In the validity test, the researcher examined the values of MNSQ, ZSTD, and Pt Mean Corr. to validate the instrument's MUCA with trigonometry materials. The research instrument consisted of 5 indicators, with 2 items for each indicator. The validation test was conducted on 81 students. The results of the validity test are deserved in the following table.

Table 2. The results of validity and reliability test.

Item	Outfit MNSQ (0.5 < x < 1.5)	Outfit ZSTD (-2.0 < x < +2.0)	PTMEA-CORR (0.4 < x < 0.85)
1	0.77	-1.4	0.78
2	0.88	-0.2	0.54
3	0.80	-1.2	0.78
4	1.28	1.6	0.70
5	1.03	0.3	0.75
(KR-20)		0.77	
Item		0.98	
Person		0.77	

Table 2 shows that all 5 items meet the criteria. To be considered valid, an item must meet at least 2 criteria (Puspitaningrum et al., 2021). This indicates that the 5 items that have met the recommended criteria have good quality. Once the instrument shows valid results, the next step is to test its reliability. The results from table 2 show that the instrument used to measure the MUCA with trigonometry material is considered reliable. Cronbach's Alpha (KR-20), Item and Person Reliability, and Item and Person Separation are used to assessing the reliability test, where the test instrument can be said reliable if the KR-20 value is > 0,70 (Barbera et al., 2021; Faradillah & Febriani, 2021). Therefore, the results of the validity and reliability tests, this instrument is deemed valid and can be used for research purposes.

The data analysis of the posttest results for mathematical concept comprehension in this research involves descriptive analysis, while inferential statistical analysis refers to statistical methods used to draw conclusions. T-test is used in inferential statistical analysis to determine the influence of collaborative learning model with the help of Augmented Reality on the mathematical concept comprehension ability.

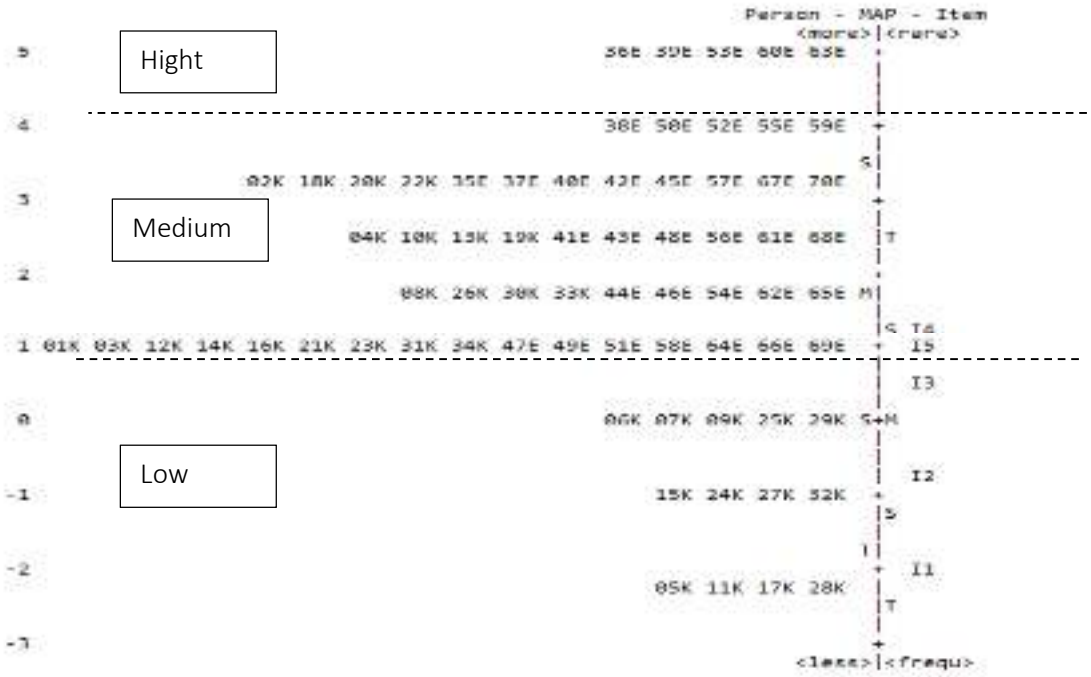

Figure 2. The result of wright maps

Figure 2 shows the classification of mathematics understanding concept ability levels, with the students' identification numbers, gender, and class codes. The degree of difficulty of each item is displayed in the right column. The Wright map is divided into two halves, left and right. The left part which means the location of each skill, and the right part shows the degree of difficulty of the item. Upper right for high-difficulty items, lower right for low-difficulty items (Hikmah et al., 2021). The percentage of mathematics understanding concept ability levels, categorized as high, medium, and low level of MUCA is presented in Table.

Table 3. The wright maps result category.

Category	Percentage
High	7%
Medium	74%
Low	19%

Findings and Discussion

The normality test examines the data to see if the residuals are normally distributed (Doddy et al., 2018). In this study, Kolmogorov-Smirnov tests were performed for the normality tests can be seen in the table below.

Table 4. The normality and homogeneity test results.

		Statistic	df	Sig.
Result Post-test	Post-test control	.141	35	.077
	Post-test experiment	.136	35	.097
	Based on Mean			.797

Data is normally distributed if the value is Asym. Sig. > 0,05 (Sugiarti et al., 2020). Using the Kolmogorov-Smirnov normality test, the data showed were normally distributed, with post-test scores of 0.77 and 0.97 for the control and experimental classes, with a significance value of >0.5. After confirming the normal distribution of the data, the next step is to perform the homogeneity test of the study. To determine whether the variance between two groups of data is equal or wider, use a homogeneity test (Setyawan, 2020). To determine if the data is homogenous or heterogeneous, we need to look at the based on mean section of the table. If the Asym. Sig. is >0.5, then the data is homogenous, while if it's <0.5, the data is heterogeneous (Gao et al., 2017). Looking at Table 8, the based on mean section has a significance value (sig.) of 0.797, which is >0.5, indicating that the research data is homogenous.

Next, a t-test is conducted, where the requirements for the test are that the data should be normal distribution and homogenous. Based on the previous test results that confirmed the data is normal distribution and homogenous, a t-test can be performed. The decision for the t-test is if Asym. Sig. (two-tailed) < 0.05, there is quite a difference between the learning outcomes of the A and B classes and vice versa (Dehghanzadeh & Jafaraghaee, 2018). The value for the experimental class and control class is 0.00 and 0.00, both < 0.05, It shows that is a significant difference between the learning output of the experimental class and the control class.

Table 5. The result Cohen's d

	class	N	Mean	Std. Deviation	d (Cohen's)
Result Post-test	Post-test control	35	65.29	9.467	2.14
	Post-test experiment	35	76.81	8.484	

Table 5 displays the results of Cohen's d and the results obtained are d = 1.28, indicating that the effect of the cooperative jigsaw model with AR on mathematics understanding of conceptual skills was classified as very large (ES > 1.2)(Hanif Batubara et al., 2022). The average score of experiment class is higher than that of control class with a value of 76.81 > 65.29. This shows that the research hypothesis H_1 accepted, H_0 rejected, which means that the cooperative jigsaw model with the help of AR has a significant effect on mathematics comprehension ability with a mean difference of 11.42.

The implementation of jigsaw cooperative learning is expected to enable students to develop analytical, creative, logical, and systematic thinking skills in identifying alternatives to solving problems. Several stages in the jigsaw model can improve students' ability to understand mathematical concepts (Sukarmini et al., 2016). First, students are divided into several heterogeneous groups consisting of 5-6 students. Each group has a group leader who is selected from the most competent students in the group.

Furthermore, the subject matter is divided into several subtopics. Each student in the group takes one subtopic that becomes their task. If other groups have students with the same

topic, they join an expert team, also known as an expert team. In an expert team, students discuss the problem they are working on and write down the main points. At the end of the discussion, the expert group returns to their original group to share and present the results of the discussion (Mudijono & Azis, 2022).

Therefore, the conclusion of this research finding is that the Jigsaw learning model is an educational approach where students are actively involved and has a positive impact on improving students' ability to understand mathematical concepts. Based on the results of the study, it can be concluded that the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. This means that it is proven that learning using the Jigsaw model has a significant impact on students' ability to understand mathematical concepts. In line with (Anitra, 2021) who stated that there is an influence in using the jigsaw learning model in schools. In addition, (Purwanti et al., 2016) where the results of the study showed an influence in jigsaw type cooperative learning on the ability to understand mathematical concepts.

Conclusion

The outcome of a investigation on the effect of a Jigsaw collaborative learning model supported by augmented reality on conceptual comprehension of students in Class X of SMA Negeri 90 Jakarta for the 2022/2023 academic year showed that the trigonometry score of experiment class 76.81 points was higher than that of the control class better than 65.29 points. Based on the data analysis with Cohen's d, the value of Cohen's d is obtained d = 1.28, indicating that the effect of the AR-supported jigsaw model on the MUCA is believed to be large (ES > 1.2). Therefore, a significant effect can be concluded on conceptual understanding by using the Jigsaw Cooperative Learning Model with Augmented Reality Assistance compared to the conventional model.

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