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Computer Assisted Instruction (CAI) Drill and Practice to Improve Spatial Orientation Ability

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Abstract

This study aimed to examine the quality of improving students' spatial orientation skills through CAI (Computer Assisted Instruction) drill and practice. This study included experiments with the Non-Equivalent Control Group Design involving students at SMPN 18 Bandung selected by teacher, with 29 students in the experimental class and 26 students in the control class. The instrument used was a spatial orientation ability test instrument. The results of this study concluded that (1) the quality of improving the spatial orientation abilities of students who received CAI drill and practice was moderate, and the quality of improving spatial orientation abilities who received conventional learning was low. (2) the increase in the spatial orientation ability of students who get CAI drill and practice is higher than students who get conventional learning.

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1. Introduction

School is an important place to advance a nation and a country. Everyone has the right to get the same education in accordance with the intent of the Law of the Republic of Indonesia Number 20 of 2003. Receiving education can develop abilities and shape dignified national character and civilization in order to educate the nation's life, develop students' potential to become human beings who believe and fear piety to God Almighty, have a noble character, be healthy, knowledgeable, capable, creative, independent, and be a democratic and responsible citizen. In the world of education, mathematics is a compulsory subject that must be studied by students, mathematics has been studied by students from early childhood education to higher education. Mathematics can produce students with the ability to think logically, analytically, systematically, creatively and critically and the ability to work together (Permendiknas No. 22 of 2006). One of the mathematics chapter materials taught in schools, from elementary to high school, is geometry.

Geometry is a part of mathematics that is close to students, because the objects around students are geometric objects (Safrina, 2014). Geometry is also part of mathematics which focuses on the study of substances, lines, fields, and spatial objects as well as their properties, sizes, and associations with one another (Rohimah & Nursuprianah, 2016). Based on the National Council of Teacher Mathematics (NCTM, 2000) geometry can develop students' abilities in mathematical reasoning, including inductive and deductive reasoning, making and validating conjectures, and classifying and defining geometric objects. What students achieve by learning geometry according to the 2013 curriculum is that students can solve problems related to the congruence of triangles or quadrilaterals, solve problems related to polygons, solving problems related to congruence and congruence, solving problems with geometric shapes. Walle (1994) argues that there are five reasons why geometry is very important to learn, namely (1) geometry helps humans have a sense of gratitude about their world, geometry can be found in the solar system, geological formations, crystals, plants and plants, stars to architectural works of art and machine work, (2)

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geometric exploration can help develop problem solving skills, (3) geometry plays a major role in other fields of mathematics, (4) geometry can be used in everyday life, (5) geometry is full of challenges and interesting.

Geometry has a greater chance for students to understand compared to other branches of mathematics, because geometry is a learning that is very close to students, because objects around students are geometric items (Safrina et al, 2014). Learning geometry is not as simple as imagined, even though it has been taught from elementary school, but there are still many students who experience difficulties when dealing with problems related to geometry (Cahyani et al, 2020). Therefore, the design and methods of learning geometry need to be developed so that students can understand learning geometry. One solution to make it easier for students to solve geometric problems or learn geometry is that students have good spatial abilities, including spatial orientation skills (Wulansari, 2019).

The ability of spatial orientation is the ability to find one's own guidance physically or mentally in space and someone in special circumstances (Maier, 1998. McGee (1979) argues that spatial orientation ability is the ability to understand the elements of a visual object to remain undisturbed by changes in orientation in which geometric shapes can be presented or it can be interpreted that spatial orientation ability is a person's ability to be able to imagine the appearance or image of an object from different perspective. Another opinion on the importance of spatial orientation ability is the opinion of McGee (1979) who revealed that the main factors of spatial ability are spatial orientation ability and spatial visualization ability. Riastuti, et al., (2017) that students who have good spatial orientation skills can solve geometry problems and can imagine the transformation of the orientation of objects and can imagine objects from various angles. Therefore, the ability to spatial orientation is an important component to improve geometry skills.

However, students' spatial orientation skills are still low, this is evidenced by data on the average percentage of questions answered correctly by TIMSS (Trends in International Mathematics and Science Study) in 2011 in Indonesia. The question is that students determine the top view of the rectangular pyramid nets that must be folded first, having the average yield data that answers the question correctly is 27%. Research conducted by Lutfi and Jupri (2020) also proves that students' orientation skills are low, students cannot imagine spatial objects with an example question: "The image in the photo is 5 cm tall. If the scale is 1:400, find the original length of the image in the photo?”. In addition, students also cannot determine the original length of the image in the photo with the given scale. therefore,

To improve students' spatial orientation skills, computer hardware and software can be used, such as sketchpad geometry and cabri geometry or other devices (Sudirman & Alghadari, 2020). The use of computer applications such as GeoGebra, Adobe Animate, Cabri 3-D, Sketchpad, and other software can assist learning so that students have an understanding and mastery of the correct concepts of the material they are studying. Of the various ways to develop spatial abilities, especially spatial orientation, researchers are interested in the use of CAI computers.

CAI (Computer Assisted Instruction) is a learning program that is used in the learning process with software in the form of a computer program containing learning material (Arsyad, 2011). CAI uses a combination of graphics, audio, text, and video for the learning process (Onasanya et al, 2006). CAI is learning in which the computer provides student material and evaluates student learning while the teacher supervises learning. Heinich et al (2002) states that there are three types of CAI learning models and Robert Taylor (in Picciano, 2010) adds one more model in the CAI learning model so that there are four CAI learning models, namely: 1) Tutorial, 2) Drill and Practice, 3) Problem Solving, and 4) Simulation.

According to the formulation of the problem above, the purpose of this study is to examine the quality of improving the ability of spatial orientation of students who have received mathematics learning using computer-based multimedia, namely CAI with drill and practice programs as well as students who have received learning with visual aids, increasing the ability of spatial orientation of students who have to get mathematics learning using computer-based multimedia, namely CAI with a drill and practice program compared to students who get learning with visual aids.

2. Method

The purpose of the research conducted by the researcher was to examine the increase in students' spatial orientation abilities and the quality of improving spatial orientation abilities. Thus, the approach taken in this research is a quantitative approach. The method used in this research is the experimental method. The research design used is quasi-experimental or quasi-experimental. The quasi-research used in this study was a non-equivalent control group design. In the experiment, two classes were taken, namely the experimental class and the control class. The experimental class received CAI drill and practice learning and carried out a pre-test and post-test in the form of a spatial orientation ability test. The control class received conventional learning in the form of visual aids and data collection in the form of spatial orientation ability tests before and after learning.The population in this study were students in one of class VIII in the even semester of the 2022/2023 academic year in the city of Bandung. The students participated in experiment selected by mathematics teacher. In the experimental class there were 29 students who took part in the activity and in the control class there were 26 students, the total number of students was 54 students.

Table 1. Spatial Orientation Ability Indicator

No.	Spatial Orientation Ability Indicator
1	Students can determine the top view, front view, and right side view of changing objects.
2	Students can predict changes in objects from different perspectives of observers
3	Students can identify the top view, front view, and right side view that corresponds to the observer's position
4	Students can find spatial patterns
5	Students can guess objects from the top view, right side view, and front view
6	Students can determine the relationship between spatial differences in objects

The data obtained from the pre-test and post-test spatial orientation abilities in both classes and questionnaires before learning and after learning in the experimental class were analyzed in several stages. Spatial orientation ability data analysis includes a normality test, homogeneity test, two average similarity tests, and two average difference tests aiming to find out whether or not there is an average difference in the mathematical spatial orientation ability of students in the experimental class and the control class. The test for the similarity of the two means and the test for the difference between the two means are very dependent on the normality and homogeneity of the data. If it meets the requirements then the test is continued (N-gain). N-gain data processing is the same as post-test data processing, namely the normality and homogeneity tests, and the average difference test. According to Hake (in Lestari & Yudhanegara, 2015), the increase that occurred in both classes can be seen using the N-gain formula and estimated using the N-gain criteria as follows:

Table 2. Percentage of Students Who Have ICT Equipment

N-gain	Information
N - gain > 0.7	High
0.3 < N-gain ≤ 0.7	Moderate
N-gain ≤ 0.3	Low

3. Results & Discussion

3.1 Spatial Orientation Ability Data Analysis

3.1.1 Pretest Data Analysis

After conducting the research, data were obtained from the experimental class and the control class. The data that was analyzed first was the pretest data of the two classes. Analysis was assisted with SPSS version 22. First, the normality test was performed, then the homogeneity of variance test was carried out using Levene's test, and the final test was the mean difference test. This analysis aims to find out that there are significant differences in initial orientation abilities between classes

Based on the SPSS version 22 analysis, it was found that the pretest data were normally distributed and homogeneous. The difference test of the two means used is the independent sample t-test of variance assumed on the pretest data. After being analyzed that the pretest data did not have an average difference. This means that the two classes do not have significant differences in initial spatial orientation abilities.

3.1.2 Posttest Data Analysis

The second analysis is post-test data analysis. Analysis was assisted with SPSS version 22. First, the normality test was performed, then the homogeneity of variance test was carried out using Levene's test, and the final test was the mean difference test with the aim of whether the posttest data could be continued with N-gain data analysis.

Based on the SPSS version 22 analysis, it was found that the post-test data were normally distributed and homogeneous. The difference test of the two means used is the independent sample t test of variance assumed on the post-test data. After being analyzed that the post-test data has an average difference. This means, the two classes have significant differences in the final ability of spatial orientation and N-gain data analysis can be carried out.

3.1.3 N-gain Data Analysis

The third analysis is N-gain data analysis. The analysis is assisted by SPSS version 22. Before conducting the test, the N-gain data is processed using the formula (Hake, 1999):

$$N\text{-}gain = \frac{S_{pos} - S_{pre}}{SMI - S_{pre}}$$

Information:

N-gain: normalized gain.

S_{pre} : pretest score.

S_{pos} : posttest scores.

SMI : ideal maximum score.

Table 4. Descriptive Analysis of Spatial Orientation Ability N-gain Data

Class	N	SMI	Means	Std. Deviance	Variances
Experiment	29	1	0.498	0.257	0.066
Control	26	1	0.279	0.355	0.127

After processing the N-gain data using the formula above, you can proceed with the normality test, then variance homogeneity test with Levene's test, and the last test is the average difference test with the formula.

$H_0 : \mu_1 \leq \mu_2$: the average increase in the spatial orientation ability of students who receive learning using Computer Assisted Instruction (CAI) drill and practice is lower or the same as the average increase in students' mathematical spatial orientation ability using conventional learning.

$H_1 : \mu_1 > \mu_2$: the average increase in the ability of spatial orientation of students who receive learning using Computer Assisted Instruction (CAI) drill and practice is greater than the average increase in the ability of spatial orientation of students using conventional learning.

Information :

μ_1 :average data N - experimental class gain.

μ_2 :average data N - control class gain .

Based on the SPSS analysis version 22, it was found that the N-gain data was normally distributed and homogeneous. The difference test of the two means used is the independent sample t test of variance assumed on the N-gain data. The results of the analysis can be seen in Table 5.

Table 5. Independent Sample Test Results T-test Data N-gain

Data	Q	Sig. (1-tailed)
N-gain Spatial Orientation Ability	2.644	0.0055

Looking at Table 5, the sig. (1-tailed) on the independent sample t test on the ability of students' spatial orientation is 0.0055. By using a significant level of 5%, the test criteria are as follows. If the value of Sig. (1-tailed) < 0.05 then H_0 is rejected, and if the Sig. (1-tailed) ≥ 0.05 then H_0 is accepted. sig. value 1-tailed in table 5. is smaller than 0.05, then H_0 is rejected according to the criteria above. This means that the experimental class that uses CAI has an average increase in spatial orientation ability much higher than the control class that uses visual aids.

3.2 Discussion

After obtaining the results of the research, a discussion of the results of the research is carried out. The discussion in this study, namely increasing students' orientation abilities.

After analyzing the N-gain data on students' spatial orientation abilities in the two classes, the experimental class obtained an average N-gain data orientation ability of 0.498 and that of the control class of 0.279 which can be seen in Table 5. In the categories presented by Hake, the class has the medium quality for CAI drill and practice and the teaching aids class gets low quality. This is caused by differences in learning, in the experimental class students are guided by CAI in learning by the tutorial section which studies the basic skills of spatial orientation and is strengthened by exercises drill and practice. Conventional scientific method class with teaching aids. Students in the experimental class can see learning through animations such as cube nets and beam nets being folded, large cubes filled with small cubes, animations showing side planes, edges, vertices, and other elements. Students are also trained with repeated questions from the application looking for the front view, the top right side view, changes in shape size, and the surface view if the observer's position is changed. In addition, there is a link that shows a 3-dimensional image that can be explored to study the front view, top view, and right side view of the cube space and blocks from various directions and positions. In accordance with Piaget's theory of cognitive development, junior high school students belong to the formal operational stage,

Classes that use CAI drill and practice, students are given directions on how to use the application, then students are told to explore the application such as opening a section of a book studying geometric material or trying a quiz first then studying geometric material and the teacher's task is to supervise and guide. Meanwhile, in a class that uses conventional learning, students form groups and the teacher gives props and student worksheets, then the teacher explains the material with props to each group, and groups of students try to explain the material back to other groups. CAI learning is in line with Vygotsky's learning theory, scaffolding is the process of providing guidance or guidance to students to achieve what must be understood from what is now known (Winaputra et al in Suardipa, 2020). The difference in quality of the two classes is different, the class that uses CAI drill and practice is more effective in understanding the elements of spatial orientation abilities more easily and flexibly, each student can study anywhere with a student device, while teaching aids can only be used during learning hours. Thus, students who use CAI drill and practice can experiment and practice more than classes that use props because the use of CAI tools can be anywhere. Even so, the quality of improving the orientation ability of students in the experimental class has not been said to have reached its maximum. This can be seen in the average N-gain score which is still relatively moderate. So that the application of CA drill and practice needs to be redeveloped, in order to obtain a high increase in spatial orientation abilities.

Based on the inferential results using the independent sample t test and N-gain score data, it can be concluded that the increase in the spatial orientation ability of students who use CAI drill and practice learning has a higher increase than students who use conventional learning. From the test results received, this research is in line with other researchers proving that CAI can improve students' spatial abilities (Yuliardi, 2015; Yuliardi, 2017; Nurjanah et al., 2020; Millard, 2014; Nurjanah, 2021; Priyanda, 2019). This can happen because CAI facilitates students to overcome difficulties related to spatial orientation abilities.

Learning using CAI drill and practice is provided with repeated quizzes, as well as three-dimensional images that can be seen from various directions to help strengthen the ability to describe or illustrate the front view, right side view and top view, and also changes in objects when viewed from a miniature building with a building original. CAI media learning also makes students imagine, arrange, process and draw shapes and geometric shapes more quickly and precisely with the front view, right side view, and top view given than students in the control class (Yuliardi, 2015; Senel, 2019; Chang, 2014; & Milard, 2014). In addition, students can study independently at home without the need to bring props from school if there is material that they do not understand or need to explore the material again. Another advantage of learning CAI with devices is that students can study anywhere, while visual aids can only do experiments such as using small cubes in the case of this study, the number of these tools is limited and can only be implemented in class. In addition, the use of CAI drill and practice media also requires students to play an active role in the learning process, such as students discussing with friends solving problems provided by CAI, asking if they have problems with the teacher, explaining opinions to other students and so on. Students get a better and deeper understanding of these activities (Priyanda, 2019). the number of tools is limited and can only be implemented in class. In addition, the use of CAI drill and practice media also requires students to play an active role in the learning process, such as students discussing with friends solving problems provided by CAI, asking if they have problems with the teacher, explaining opinions to other students and so on. Students get a better and deeper understanding of these activities (Priyanda, 2019). the number of tools is limited and can only be implemented in class. In addition, the use of CAI drill and practice media also requires students to play an active role in the learning process, such as students discussing with friends solving problems provided by CAI, asking if they have problems with the teacher, explaining opinions to other students and so on. Students get a better and deeper understanding of these activities (Priyanda 2019).

The CAI application also displays interactions with students such as buttons pressed when choosing answers during quizzes, and answer boxes that must be filled in when looking for volume and surface area formulas of blocks and cubes from the animation being played. This activity also trains students to reason about geometric objects, where the problem of flat shapes is not only cubes and blocks, it could be a combination of blocks and cubes to become a new flat shape which means it is important for students to be able to understand illustrations of geometric drawings. Similar to the research results of Nurjanah et al., (2021) that computer-based media contributes to students' reasoning achievements, especially the topic of plane geometry being studied.

4. Conclusion

Based on the research that has been done, it can be concluded that the quality of improving the spatial orientation abilities of students who receive learning using the Computer Assisted Instruction (CAI) drill and practice media model is moderate (average N-gain score 0.498), while improving students' spatial orientation abilities those who get conventional learning are in the low criteria (average N-gain score 0.279). Meanwhile, the increase in the spatial orientation ability of students who received learning using the Drill and Practice Computer Assisted Instruction (CAI) media model was higher than the increase in the spatial orientation ability of students who received conventional learning.

Based on the research results and conclusions, the following suggestions will be put forward, namely the quality of improving the spatial orientation ability of students who receive learning using the Computer Assisted Instruction (CAI) drill and practice is higher than the increase in the spatial orientation ability of students who receive conventional learning, then the media model Computer Assisted Instruction (CAI) drill and practice can be used when the teacher wants to improve students' spatial orientation abilities. According to TIMMS, Indonesia's spatial orientation rating is at 44th with the CAI drill and practice learning media.

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