

Chapter 4 Research Method

This chapter describes the research methods which are summarized in several sections in this study.

4-1 Type of Research

This study using the mix-method to combine quantitative and qualitative research. We make an android application called Authentic-UG to facilitate students and Dashboard-UG to facilitate teachers then we analyze the learning behavior in the concept of line and concept of angle measurement.

4-2 Research Architecture and Research Variables

The structure in this study can be seen in Figure 14 about the research architecture, and the research variables such as control variables, dependent variables, and independent variables.

4-2.1 Control Variable

In this study the variable of learning topic, learning time and learning place as a control variable which is a variable constant and cannot be replaced because students learn on predetermined topics, during school time and take place outside the classroom.

4-2.2 Independent Variable

Independent variables are variables that cannot be influenced by other variables, and in this study, there are one independent variables with two attributes category such as experimental group (EG) that students using Authentic-UG for learning and control group (CG) consisting of students who use the conventional method for learning.

4-2.3 Dependent Variable

Dependent variables are variables that can be influenced by other variables. In this study, there are three categories of activity in the dependent variables: the learning behavior that is explained in Table 4, the learning assessment described in Table 5, and learning achievement described in Table 6.

Table 4. Learning Behavior Variables

Activity	Variable	Definition
Quantity of measurement	Number of Records	Number the records or authentic of work
	Total Time Making Records	The total time used to make record
	Total Time Learning	Total time spent to read learning material
	Total Step with Pedometer	Total walking students' step
	Total Trying Making Records	Total experiments by students
Quality of measurement	Accuracy of Line on Line Topic	Accuracy of Line or Accuracy of Angle on each topic
	Accuracy of Line on Angle Topic	
	Accuracy of Line on Combine Topic	
	Accuracy of Line on Triangle Topic	
	Accuracy of Line on Quadrilateral Topic	
	Accuracy of Angle on Angle Topic	
	Accuracy of Angle on Combine Topic	
Accuracy of Angle on Triangle Topic		
Accuracy of Angle on Quadrilateral Topic		
Annotation	Annotation	Annotation using manual score

Table 5. Learning Assessment Variables

Activity	Variable	Description
Teacher Assessment	Teacher Assessment	Total Score of teacher assessment
Peer Assessment	Peer Assessment on Linguistic	Total Score of student explanations
	Peer Assessment on Logical	Total Score of student symbol representation
	Peer Assessment on Visual	Total Score of graphical representation

Table 6. Learning Achievement Variables

Activity	Variable	Description
Post-test	Recognizing angle, line and shape (R)	Total score of each dimension
	Making & measuring angle, line, shape (MM)	Total score of each dimension
	Line and Angle estimation (E)	Total score of each dimension
	Identifying angle, line, and shape properties (I)	Total score of each dimension
	Total Post-Test	Total score of final post-test

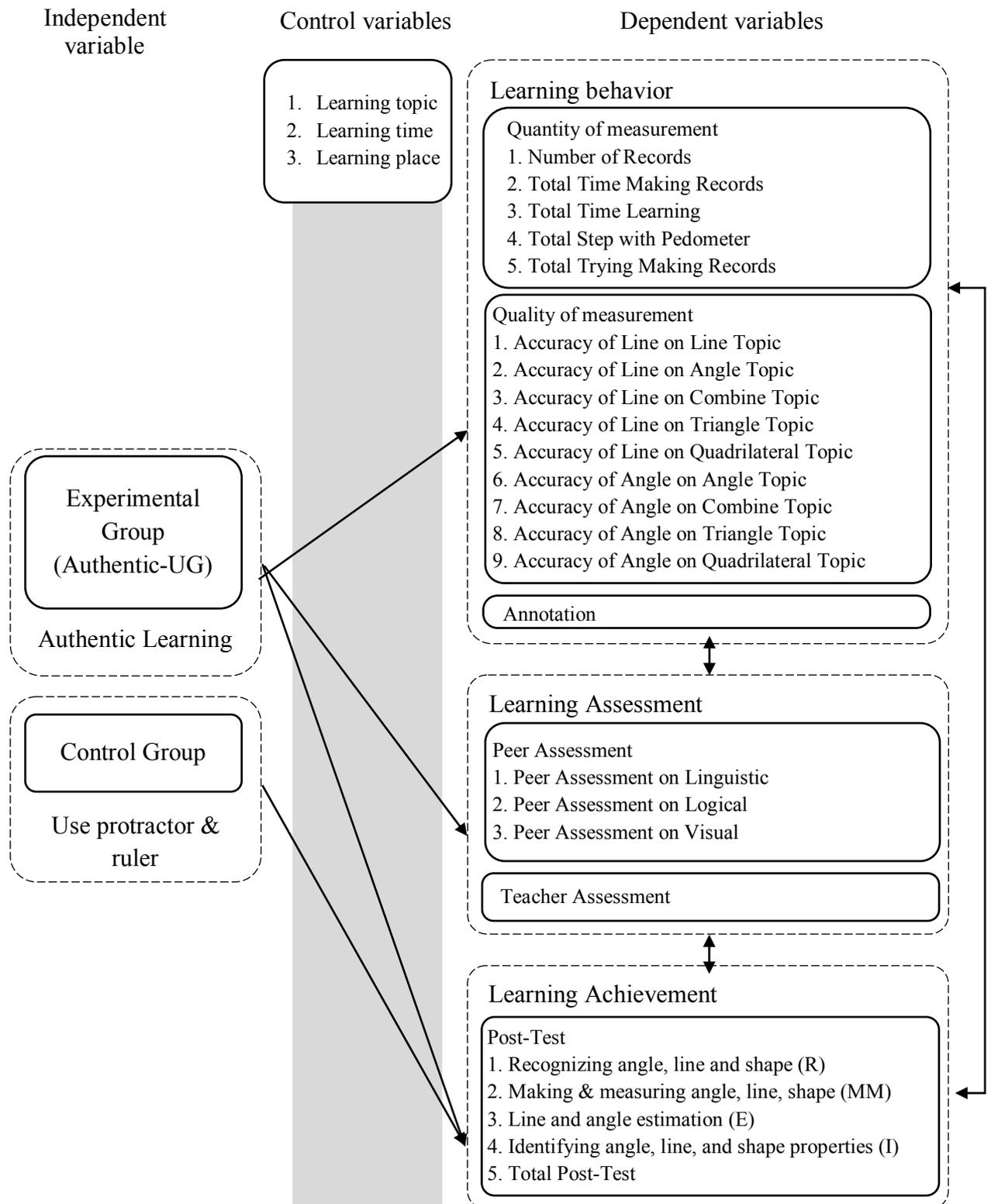


Figure 14. Research Architecture

4-3 Research Flow and Procedure

There are six stages in this study which can be seen in Figure 15, which starts making a system for students and teachers to produce a conclusion.

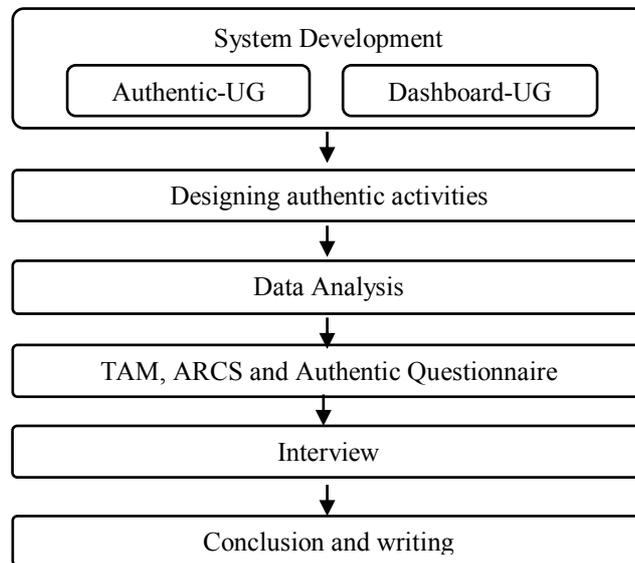


Figure 15. Research Flow

Figure 15 at above shows there are six stages, which are described as follows:

1) System development

At this stage, we develop Authentic-UG application based on Augmented Reality technology that allows students to learn geometric concepts and measurements with authentic environments. We also develop web-based Dashboard-UG that have various analysis from xAPI which can displayed with interactive graphics.

2) Designing authentic activities

We design activities so students can learn concepts in geometry with various topics and levels of difficulty based on location.

3) Data Analysis

Activities on the system are recorded using the xAPI system and then stored into the online cloud after that do the analysis automatically or manually.

4) Questionnaire

We designed a questionnaire based on the TAM (Technology Acceptance Model) and based on the ARCS questionnaire to find the students' perceptions when using the system and also to determine students' motivation. We also design authentic learning questionnaire to investigate after applying authentic learning design.

5) Interview

We conducted interviews with students to strengthen our findings in this study that the details show in Appendix 8.

6) Conclusion and writing

At this final stage, we take conclusions on the learning of authentic activity in the outside classroom to understand the concept of angle in with real authentic object, the experimental procedures that we apply can be seen in Figure 16.

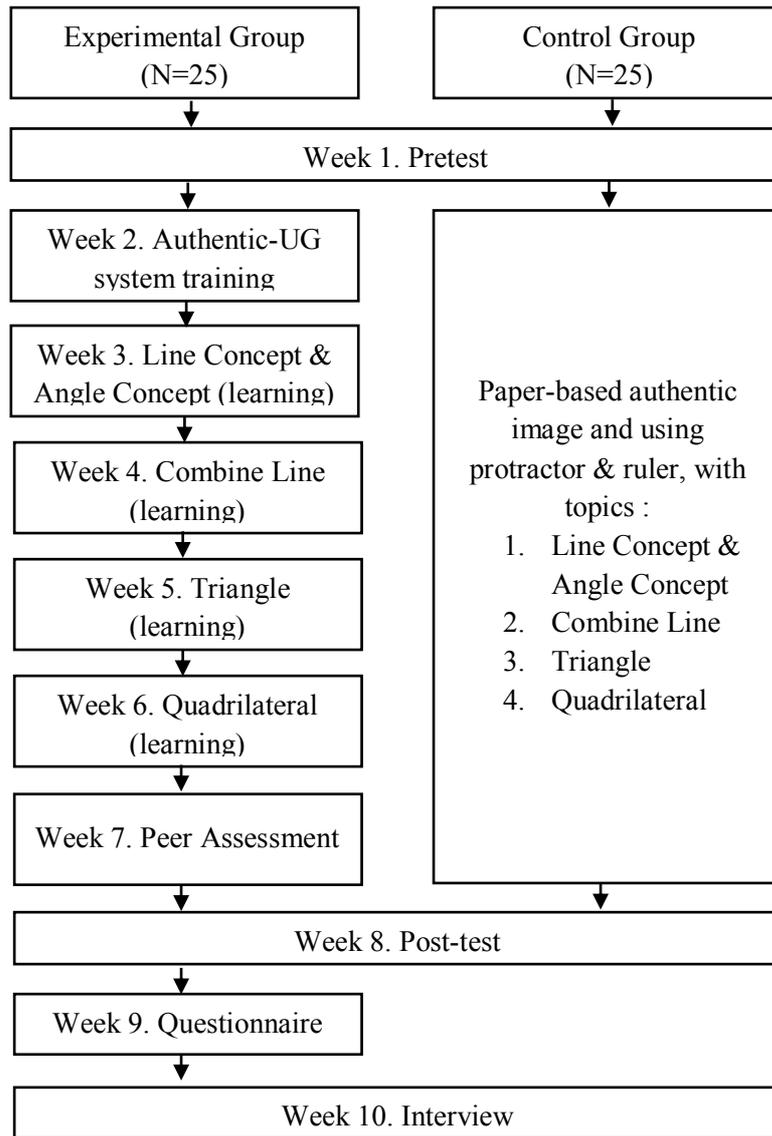


Figure 16. Experimental Procedure

4-4 Research Subject

Participants in this study were the 4th grade of students in elementary school with two groups in different class with same teacher, an experimental group (EG) with 25 students and

a control group (CG) with 25 students. At the initial, we held a pre-test for two groups to ensure that they had the same initial prior knowledge. Students in experimental groups learn geometry using Authentic-UG, then for control group using conventional learning methods that use paper-based with authentic images around the school environment. The duration of learning in both groups was the same that 40 minutes per class for 10 weeks.

4-5 Research Tool

We use several tools to collect data using xAPI technology on Authentic-UG such as making scaffolding to facilitate students and teacher in for assessments, questionnaires, and interviews.

1) Learning Behavior

Data in the learning behavior using comparison between the results of work and the existing questions to be able to know the accuracy of angle and accuracy of line, and before to do learning the student do pre-test that show on Appendix 4.

2) Learning Assessment

Data in the learning assessment uses multiple representation assistance used by teachers and students in conducting assessments summarized in the Table 7 below.

Table 7. Learning Assessment Scoring Rubric

Assessment	Score
Teacher Assessment	5: accuracy 81 up to 100 + correct work
	4: accuracy 81 up to 100 + wrong work
	3: accuracy 51 up to 81 + correct work
	2: accuracy 51 up to 81 + wrong work
	1: accuracy 0 up to 50 + correct work
	0: accuracy 0 up to 50 + wrong work
Peer Assessment	0-1: Is the explanation correct? (linguistic)
	0-1: Is the angle correct? (logical)
	0-1: Is the symbol of angle correct? (visual)

3) Learning Achievement

Data on the learning achievement was obtained using the results of the post-test with multiple choice questions and essay questions that show in Appendix 5.

4) Student Perception

Data on student perception was obtained using a questionnaire based on the TAM about perceived usefulness, perceived ease of use, attitude toward use, and behavioral intention.

Data on student motivation was obtained using a questionnaire based on the ARCS about attention, relevance, confidence, and satisfaction. Also, data on authentic learning was obtained using an Authentic Learning questionnaire about learning by applying, healthy learning, collaborative learning, creativity, sustainability, and scalability.

5) Interview

We conducted interviews to get qualitative data to support the results of this study.

4-6 Experimental Activities

The activities in this study fully use Authentic-UG to support authentic learning outside the classroom. The activities in the experiment group are as follows:

1) Learning topic

Students open one topic from several available topics, then students learn according to the topic and subtopic that was opened.

2) Create authentic of work based on the problem in the question

The system will display a question based on an authentic problem to look for an authentic geometry object that matches the problem and find it based on location. Then, students make lines, angles, and shape using Authentic-UG.

3) Answering question

Students need to explain the results of the authentic of work based on images and videos that are created and use annotations on multimedia whiteboards.

4) Peer Assessment

In this activity, students are divided into several groups to provide an assessment to their peers with multiple representation (scaffolding). After completion, then it can provide an assessment to another student

5) Teacher Assessment

The teacher assessment based on the results of students' authentic of work using the level of accuracy and the correctness.

4-7 Experimental Function

There are several features that are contained on Authentic-UG that can be used by students in authentic learning activities outside the classroom.

1) Learning Material

There are learning materials on each topic, each student can open the learning material according to the topic and the system will record each student's activities while read on learning material.

2) Making of Authentic based on location

The main features in Authentic-UG when students can make geometry objects in real time using the Augmented Reality technology.

3) Multimedia Whiteboard

Students can add annotations, visual representations and symbols also can explain the result authentic of work that has been made.

4) Peer sharing and assessment

Students can choose peers and can assess their peers to give assessment using scaffolding assistance.

5) Details Authentic of Work

Students can see the results of authentic work based on location, data displayed in the images of augmented reality objects, detailed accuracy, location and process of making authentic of work in the video.

6) Leaderboard / rank

Authentic-UG provide rankings based on the quantity and quality of work which are displayed to motivate all students.

4-8 Data Collection and Processing

We use scores from pre-test and post-test in the experimental group and the control group to be analyzed, and use some statistical analysis to test such as:

- 1) Independent T-Test used to test the difference in significance of initial prior knowledge for the pre-test and to test the results of the post-test on between experiment group (EG) and control group (CG)
- 2) Pearson Product-Moment Correlation Analysis used to test the correlation each variable.
- 3) Stepwise Multiple Regression used to predict the strongest factor of all existing variables.
- 4) Laq-Sequential Analysis (LSA) used to identify the sequence of students' activities when applying authentic problem using Authentic-UG
- 5) The mean comparison analysis used to analyze the results of the TAM questionnaire, ARCS questionnaires and Authentic Learning questionnaire.