Mathematics teaching Aids to improve the students abstraction on Geometry in Civil Engineering of State Polytechnic Malang

M L Dewi*, A R Hakim, A Setiawan, S Adhisuwignjo and E Rohadi
State Polytechnic of Malang, East Java, Indonesia

*mulinde13@gmail.com

Abstract. Many factors cause the polytechnic students have math difficulties, among others basic math is low, there are too many topics, and lack of time allocation. Therefore, efforts should be made to provide alternative styles of learning. One of the efforts to optimize the learning of mathematics is Math learning by Teaching Aids or APEM (abbreviation of Alat Peraga Edukatif Matematika), especially in Geometry. The Teaching Aids make students to be more active learning in acquiring knowledge and developing thinking. The objective of this research is to describe Geometry topic with Teaching Aids to improve student’s abstraction. The results obtained are: (1) The ability of the students is very heterogeneous, (2) Students of Vocational High School (SMK) are more skilful in describing the three-dimension compared to students of Senior High School (SMA), (3) The Teaching Aids of three dimension is needed to solve problems of Geometry,(4) Of the six groups, only one group is answering correctly about the volume of Concrete Construction, and (5) the average score of three problems are 85, 53, and 43.

1. Introduction
Many students of Civil Engineering have problems in Mathematics. This can be seen from the Mathematics score, many students got less than 40 in their tests. Students were given the chance to do remedial test, but their score remained maximum 40 or D. As a result, the students could be dropped out, because there is no short semester nor repetition in State Polytechnic Malang. According to the students, Geometry is the most difficult subject, many students are unable to make the formula, because the students’ abstraction is weak, they can’t construct the three dimension. Therefore the students need assistant by using factual objects, such as Teaching Aids. According to [1], there is significant influence of the use Teaching Aids on the students’ achievement and [2] said the Teaching Aids can improve students’ activity when they are learning Math concept. According to [3], use Teaching Aids would be better effectiveness and improving the quality of teacher.

In this research, various Teaching Aids are given in the form of three dimension, they have to find the surface of the area and the volume. The students are divided in six groups, each group consists of four students. The answer should be presented in turns. There are three Teaching Aids given in related with Concrete Construction in line with Applied Mathematics Module. Each Teaching Aids is made three pieces, each group gets one set of Mathematics Teaching Aids.

The aims of study are:
• To improve the students’ abstraction
  At first, there were only two student out of twenty students who could describe the three
dimension. By using the Teaching Aids all of the students will be able to draw the three
dimension.
• To ease the students to make the formula
  By using the Teaching Aids, the students will be able to identify the shape of the construction
which consist of some three dimension. If the have already known the shape, they will be able
to make the formula.
• To motivate the students to solve the Geometry problem.
  By using the Teaching Aids, the students are more interested and are more exited.

2. Math for Civil Engineering
Mathematics in D4 Study Program in Construction Engineering Management is given in semester 2 with
the time allocation 3 hours/ week, because Mathematics is the main support subject in Civil Engineering,
such as Statics, Soil Mechanics, Drawings, etc. Mathematics topics needed are among others
Trigonometry, Geometry, Derivative, Integral, Matrix, and Determinant. According to the students, the
most difficult topic is Geometry. There are three problems taken from the Applied Mathematics Module
Chapter Geometry as follows.

a. Steel beam with size 40 mm x 120 mm x 6 mm drilled as many as 4 pieces with a diameter of
10 mm on the largest beam surface. Calculate the percentage of the volume of waste material.
b. The following Figure 1 shows the top and the front view of a tent. If x = 3.5 m, calculate the
area of the tent roof and the Volume of the Tent Room.

c. Compute the volume of Concrete Construction of figure 2.2 if the radius is 4 m and x = 8 m.

![Figure 1. Top and front views of tent.](image1)

![Figure 2. Concrete construction.](image2)
In this problem, the construction is just seen from Top and the A-A cutting. The first step to do is to
draw the three dimensions, then to make the formula and last to do the computation. To ease the students
to solve the problems, visual Teaching Aids is made as shown on figure 2.3 and figure 2.4 with the
following construction.

![Concrete construction visually](image)

**Figure 3.** Concrete construction visually.

![Concrete construction visually by A-A cutting](image)

**Figure 4.** Concrete construction visually by A-A cutting.

The result of Widjajanti research [4] shows that one of the factors students have difficulty in
Mathematics is because of the weak abstraction. They have difficulty to construct the Mathematics
problems to become Mathematics Model, in the form of Equation, Formula, Graph, and Draw. They
need to be reminded, how to make equation as learned in Junior High School and Senior High School,
how to choose the exact Formula, how to make Graph and Draw. Besides having problem to construct the object, they also have problem to make the formula. They are not able to apply the formula of three dimensions in Geometry. Therefore, it is necessary to help the students to solve the problem related with three dimensions or Geometry. The effort to do this is Mathematics learning assisted by Teaching Aids. The aim is to improve the student abstraction and to help them to solve Geometry problems.

In Math it is not easy to differ, which is pure Math from applied Math. Because the objects of Math are abstracts. In Civil Engineering Trigonometry and Geometry are very much needed and discussed about [5].

3. Method
The main aim of this research is to improve the students’ abstraction skill. So, when during Geometry learning the students are assisted by Teaching Aids. The steps of Geometry learning are as follows.

- It is recommended not to show the Teaching Aids in advance
- Give the students time to draw three dimension
- Check the Figure before showing the Teaching Aids
- When the Figure is correct, then the calculation to be started

4. Result and discussion
There were two points observed during the Math learning, which were motivation and effectiveness. The students showed high motivation when they were solving the Math problems by using the Teaching Aids. This was reflected, the students were active and exited.

The Teaching Aids of three problems above are as follows:

Figure 5. The steel beam.

Figure 6. The tent.
Based on the implementation of Teaching Aids in the classroom, the result is described as follows.

- In terms of learning materials, the Teaching Aids is not only needed by students majoring in Civil Engineering, but is also helpful for the students of other majors. According to [6], the use of Teaching Aids can improve students’ mastery of vocabulary learning.
- Viewed from the aspect of display, APEM is not dangerous, students are interested and have high motivation to solve math problems. Also the Teaching Aids can be made from material around us. According to [7], the learning activity by using Teaching Aids which is designed based on local wisdom, has significant influence on the Kindergarten students to skill in English for Math learning and also on their fondness of local product around them.
- Students are able to work in groups to calculate the volume of construction.
- The average score for three problems are as follows.
  a. Result 1: all groups can draw three dimension and the average score is 85
  b. Result 2: there are two group can draw three dimension and the average score is 53
  c. Result 3: not any group can draw three dimension and the average score is 43

5. Conclusion
Based on the results of the implementation of mathematics learning using Teaching Aids, the following conclusions are obtained:

- Students are active and happy to solve Geometry problems by the Teaching Aids.
- With teaching aids, students are able to solve the Geometry problem correctly
- Students are able to write the exact calculation formula, if there are mistakes it is because of inaccuracy in computation.
- The Teaching Aids can increase students' abstraction ability.
- The ability of students is very heterogeneous, so the lecturer needs a strategy to help students with low ability.
- The students from Vocational High School are more skilled in describing the three dimension than the students from Senior High School.
- Three dimension is needed to solve the Geometry problem.

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