The improvement of trigonometry ability through connected mathematics learning models and scientific approaches

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Abstract. The objectives of the study was to determine the effect of the connected math learning model with a scientific approach to the ability to understand the concept of trigonometry. This study is a quasi-experiment with a sample of 80 students of Class X Senior High School Bengkulu. This research instrument is a test of comprehension ability of trigonometric concepts. The analysis of data with Ancova. The result of the research were the ability to understand the concept of trigonometry of students taught by the learning model of connected mathematics is higher than students who are taught conventionally for students who learn through the scientific approach. The ability to understand the concept of trigonometry students taught by the connected mathematics learning model was lower than students who are taught conventionally for students who study without a scientific approach. The ability to understand the concept of trigonometry students who learn through a scientific approach was higher than students who learn without a scientific approach for students who are taught connected mathematics learning models. The ability to understand trigonometric concepts of students who learn through a scientific approach was lower than students who learn without a scientific approach for students taught with conventional learning.

1. Introduction
The trigonometry is a branch of mathematics that deals with triangles. The experience, students are taught trigonometry structurally, as a result students cannot connect trigonometry with their lives. In fact, trigonometry is closely related to the student environment. According to Wongapiwatkul [1] the geometry of the Earth provides a good opportunity to integrate real-life experience into trigonometric education. An integrated approach to science education in general, and to mathematics education in particular, helps bring various topics to life and increases students' attention to potentially difficult and other interesting topics. Therefore, trigonometric learning must be connected, so that mathematics education provides opportunities and leads students to rediscover (reinvent) concepts or principles [2,3].

The mathematics is a set of devices to describe, analyze, and predict system behavior in the real world [3]. For that reason, in learning mathematics must start from the situation of students' problems (contextual problems) so that they can imagine or connect with the real world which is often referred to as a realistic mathematical approach [4]. The study of Fauzan [5], students have a strong tendency to depend on real and realistic world knowledge in solving problems. The realistic learning has a positive effect on realistic modeling and problem interpretation in arithmetic word problems. In addition, the
understanding mathematical concepts for students taught with realistic mathematics approaches improve significantly [6]. Therefore, connected mathematics learning is the right choice.

According to Lapan et al. [7], the overarching goal of connected mathematics is to help students and teachers develop mathematical knowledge, understanding, and skills, as well as awareness and appreciation of the rich relationships between mathematical strands and between mathematics and other disciplines. The results of the study [8], show that the use of Connected Mathematics shows a consistent, positive effect on students' conceptual understanding and problem-solving abilities without sacrificing achievement in computational fluency.

The implementation of connected mathematics learning to help students and teachers develop mathematical knowledge, understanding, and skills, as well as awareness and appreciation of the enrichment of interrelationships between mathematical parts and between mathematics and other subjects [7]. According to Cain [9], the connected mathematics project (CMP) schools significantly outperform non-CMP schools on both standard tests. Teachers and student state that the CMP program helps students become better problem solvers. It was supported [10], that CMP is a program that has documented success in teaching mathematical concepts and problem solving.

The CMP implementation improves the way students learn mathematics and applies their knowledge about problem solving [7]. Students who was previously had traditional teaching in mathematics begin to change the way they think and talk about mathematics [10]. Furthermore, with a scientific approach students can learn to make guesses and collect data to reach conclusions. Scientific approaches utilize technology in trigonometric learning. According to Smyth [11] one of the major changes is the availability of technology to help students engage with the concept of trigonometry. This certainly makes it easy for students to understand mathematics as a whole [12]. Also, Smyth [11] states that students can interact directly with trigonometric ideas through media technology in a more active way than is possible with paper and pencil only. While the possibilities in any class will of course depend on the particular technology available. Therefore, there is much to be gained from the use of the most advanced technology.

Students learn to use technology that is connected to mathematics, must involve their cognitive processes. According to Widada et al. [13] to be able to determine the level of mathematical understanding, the teacher must determine what can be observed as a representation of students' thoughts internally. Also, it can facilitate students to reach a high level of mathematical understanding [14].

Based on the description above, we discuss the enhancement of trigonometric understanding skills through the implementation of connected mathematics learning and scientific approaches.

2. Methods
This research is a quasi-experimental. The implementation is in SMA N 10 Bengkulu. The sample is selected by intact group technique. The total sample is 80 students. The research design is 2x2 factorial. The research instrument is a test of the ability to understand the concept of trigonometry. Data collection techniques through tests. Data analysis with ANCOVA. The covariate is the initial ability of students in understanding trigonometry. Initial ability tests are carried out before treatment.

3. Results and discussions
Suppose connected mathematics learning abbreviated CM and the scientific approach is SA. Then conventional mathematics learning becomes KM and not the scientific approach is NA. We treated each CM with SA in Class A1B1, KM and SA for Classes A2B1, CM and NA in Class A1B2, and the control class was treated with KM and NA in Class A2B2.

Based on the treatment data, it was analyzed using ANCOVA. This analysis is done by controlling students' initial ability to understand trigonometric concepts. The results are presented and described Table 1.
Table 1. Levene’s test of equality of error variances.

| F   | df1 | df2 | Sig. |
|-----|-----|-----|------|
| 0.347 | 3   | 76  | 0.058 |

Based on Table 1, it can be described as follows. Pair of hypotheses:

- Ho: \( \sigma^2_1 = \sigma^2_2 = \sigma^2_3 \)
- Ha: besides Ho

The Levene’s test shows variance errors with \( F = 0.347 \), df (3, 76) and p-value = 0.058 > 0.05. Based on this statistical test means that Ho is accepted. Because Ho is accepted, it can be concluded that the average parameter of the four groups of sample data is to have the same (homogeneous) variance.

Table 2. Tests of between-subjects effects.

| Source               | Type III Sum of Squares | df | Mean Square | F    | Sig. |
|----------------------|-------------------------|----|-------------|------|------|
| Corrected Model      | 11538.355*              | 7  | 1648.336    | 140.362 | 0.000 |
| Intercept            | 14025.738               | 1  | 14025.738   | 1194.340 | 0.000 |
| A * B                | 143.917                 | 3  | 47.972      | 4.085  | 0.010 |
| X                    | 2069.047                | 1  | 2069.047    | 176.187 | 0.000 |
| A * B * X            | 8.504                   | 3  | 2.835       | 0.241  | 0.867 |
| Error                | 845.532                 | 72 | 11.744      |        |      |
| Total                | 3333150.000             | 80 |             |        |      |
| Corrected Total      | 12383.887               | 79 |             |        |      |

Based on data analysis in Table 2, it can be concluded that the regression alignment of the four treatment groups is as follows. Hypothesis Pair:

- Ho: \((AB)_{ij} X = 0\)
- Ha: besides Ho

Column A * B * X shows that \( F = 0.241 \) with df (3, 72) and p-value = 0.867 > 0.05, which means that Ho is accepted. Thus it can be concluded: the regression coefficients of the four groups are homogeneous, or the four regression equations are parallel.

Based on the prerequisite test above, that the data variance of the understanding ability of trigonometry is homogeneous, and the four groups form parallel regression equations, then ANCOVA can be continued as follows.

Table 3. Estimates parameters.

| Parameter | B     | Std. Error | t     | Sig. |
|-----------|-------|------------|-------|------|
| Intercept | 48.021| 1.542      | 31.145| 0.000|
| X         | 0.987 | 0.062      | 15.825| 0.000|
| A1B1      | 11.211| 1.333      | 8.411 | 0.000|
| A1B2      | -2.821| 1.361      | -2.072| 0.012|
| A2B1      | 10.871| 1.363      | 7.974 | 0.000|
| A2B2      | -3.161| 1.331      | -2.375| 0.020|
Table 3 illustrates the results of the t-test (column A1B1) which shows $t = 8.411$ and p-value $= 0.000 < 0.05$ which indicates that Ho is rejected. Thus, the ability to understand the concept of trigonometry of students taught by related mathematical learning models is higher than students taught conventionally for students who learn through a scientific approach. Furthermore, the results of the t-test in the A1B2 column indicate that $t = -2.072$ and p-value $= 0.032 < 0.05$, which means that Ho is rejected. Therefore, the ability to understand the concepts of trigonometric students taught by connected mathematics learning models is lower than students taught conventionally for students who study without a scientific approach. In column A2B1 shows that $t = 7.974$ and -value $= 0.000 < 0.05$ which means that Ho is rejected. This is meaningful, the ability to understand the concept of trigonometric students who learn through a scientific approach is higher than students who learn without a scientific approach to students who are taught connected mathematics learning models. In the last column, namely A2B2, the results of the t-test with $t = -2.375$ and p-value $= 0.020 < 0.050$, which means that Ho is rejected. Therefore, the ability to understand the concept of trigonometry of students who learn through a scientific approach is lower than students who learn without a scientific approach to students who are taught with conventional learning.

The results of this study provide recommendations that the connected mathematics learning model and scientific approach can replace conventional learning. According to Phillips [15], with regard to the mathematical concepts in CMP, it’s the best program. The conceptual understanding and the strands (algebra, geometry, number, and data), go far beyond what we have ever done before. Lapan et al. [7] state that more knowledge from cognitive science has supported the idea that students develop their own understanding of their experiences with mathematics. Therefore, CMP is organized so that students continue to solve problems that contain important mathematical concepts and skills. Based on Widada [16], the mathematical activities (such as the process of abstraction, generalization and idealization [17] are carried out through interpersonal interactions of students and learning resources as well as adults who have abilities over cognitive development. Also, an increase in conceptual understanding was needed in the process of mastering concepts in mathematics [6].

Thus, we support increasing understanding of trigonometry through CMP implementation. This study significantly shows the importance of connected learning models and scientific approaches.

4. Conclusion

The statistical analysis shows that CM learning models are better than conventional. Also, the scientific approach provides an increased understanding of trigonometry. The ANCOVA was controlled the initial ability of students, and the results can be concluded that: the ability to understand the concept of trigonometry of students taught by the CM learning model is higher than students taught conventionally for students who learn through a scientific approach. Also, the ability to understand the concepts of trigonometric students taught by the CM learning model is lower than students taught conventionally for students who study without a scientific approach. In addition, the ability to understand the concepts of trigonometric students who learn through scientific approaches is higher than students who study without a scientific approach to students who are taught the CM learning model. Finally, if students are taught with conventional learning models, then the ability to understand the concept of trigonometry of students who learn through scientific approaches is lower than students who learn without a scientific approach.

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