Exploring the effectiveness of using GeoGebra and e-transformation in teaching and learning Mathematics

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Abstract: - The integration of technological tools especially computer softwares has been widely practised in teaching and learning especially in mathematics. Various types of dynamic mathematical softwares, such as Geometer’s Sketchpad, Autograph and the Graphing Calculator, have been utilized for learning mathematics in Malaysian secondary schools. However, the use of an open source software in teaching and learning mathematics is still new in Malaysia. This paper compared the effectiveness of using an open source software i.e. GeoGebra and a courseware developed by the researcher for learning transformation. Purposive sampling was carried out and a total of 70 secondary school students from a school in Malaysia participated in the study. These students were randomly assigned into two separate groups. Each group underwent instruction utilizing either the GeoGebra or the e-transformation software. Findings showed that significant differences existed between the pre and post tests scores of each of the GeoGebra and e-transformation groups. However, there was no significant difference in the performance scores on the post test of both groups. Further analysis also showed there was no significant difference on each topic included in the post test. These findings showed that both computer softwares had been effective in teaching mathematics at Malaysian secondary school level.

Key-Words: - GeoGebra, Transformation, Reflection, Rotation and Mathematics

1 Introduction

Education system has begun to change very drastically in the presence of Information and Communication Technology (ICT). Most countries have begun to integrate the use of ICT in their education system. The Malaysian Government through the Ministry of Education and Ministry of Higher Education also planned to integrate ICT in the Malaysian education system. The use of computers in teaching and learning has become a catalyst to positively change the approach to teaching and learning, especially for mathematics courses. Now there are many mathematical softwares in the market, such as Mathematica, Matlab, Maple V, Geometers’ Sketchpad, Autograf, Graphic Calculator and others. These software tools can provide a powerful symbolic and numerical calculations, can produce quick calculations and also assist students in abstract mathematical concepts. However, the use of any mathematical software such as the above requires high expenditure, should the government decides to implement it in all schools.

The existence of open source softwares can overcome this problem. Currently, there are companies and individuals who develop mathematics softwares and
distribute them for free to the public. The term open source software has become increasingly popular among computer users who seek an alternative to paid softwares. Through search engines we can have a variety of mathematical softwares which can be downloaded and used free of charge. Mathematical software such as Maxima, Scilab, Axiom, YACAS, are ready to be downloaded and used for teaching and learning. In addition, teachers who have skills in programming can also develop their own mathematical software for their students to use. A courseware such as this has advantages as it is developed specifically for their own students.

Many studies have been conducted to determine the suitability or effectiveness of the use of computer software in teaching and learning mathematics. The results of using computers to assist in the instruction of mathematics have been mixed. For example, studies by [5] compared the use of Ethnomathematics software and the traditional method. The findings indicated that there were significant differences on the test scores between the two groups with students who used the Ethnomathematics software achieved higher scores. Research by [8] showed that teaching and learning mathematics utilizing the graphing calculator was found to be instructionally efficient significantly, compared to the conventional and Autograph software. Meanwhile, findings by [4] indicated that the use of Geometers Sketchpad (GSP) induced higher mathematical thinking process amongst the GSP group. These findings showed that the use of GSP had an impact on both mathematical thinking process and performance.

On the other hand, research findings also indicated that there were no advantages in terms of students’ performance using technological tools in teaching and learning mathematics. For example, [6] and [7] reported that there was no significant differential effect between conventional teaching and the use of graphing calculator. Research by [3] also found that no significant difference in the college students’ achievements between those who attended Introduction to Statistics course using the traditional method and those using the computer. Studies by [10] on the use of electronic books for Pre-calculus courses at the university showed that no significant difference occurred in the pre-test, but was significant in the post-test. [9] had compared students’ achievement between those who attended mathematics tutorial classes conducted by lectures and the one using the computer. Results showed that there was no significant difference in students’ achievement between both groups. Studies by [1] compared performance of students using web based interactive tutorial and the traditional method for a mathematics course. Findings indicated that both groups had significant differences between the pre and post tests, but not significant on the post test performance between both groups.

Most of the studies discussed is referring to the use of either paid mathematical softwares or handheld technology. Rarely we could find studies conducted on the use of an open source software. This is because many educators still hesitate to use this type of software in class. Discussion about the effectiveness and benefits of the usage of an open source software tends to be on forums, blogs, wikis and so forth, without without proper scientific research. The discussions are personal views by users who may have used the software.

2 Purpose

The purpose of this study was to investigate students’ performance score using GeoGebra and e-transformation in the learning of mathematics by Form two secondary school students’ on the topic of Transformation. GeoGebra is an open source software while e-transformation is a computer based learning courseware, specially developed for learning transformation. Specifically, the objective of this study was to compare the effects of utilizing the two technologies (GeoGebra and e-Transformation) on various performance measures in learning the topic on transformation.
Research hypotheses of this study are:

i. There is a significant difference on the pre and post test performance scores for the group that used GeoGebra in learning mathematics.

ii. There is a significant difference on the pre and post test performance scores for groups using e-transformation in learning mathematics.

iii. There is a significant difference on the pre test performance scores for groups using GeoGebra and e-transformation in learning mathematics.

iv. There is a significant difference on the post test performance scores for groups using GeoGebra and e-transformation in learning mathematics.

v. There is a significant difference on the performance scores on each of the topics (transformation, reflection and rotation) for groups using GeoGebra and e-transformation in learning mathematics.

3 Methodology

A true experimental design was used for this study with students being randomly assigned into two groups. One group used GeoGebra while the other used e-transformation. In this study, there is no control group because both groups underwent computer based learning. Four phases were conducted: 1) The Pre Testing phase; 2) Introduction to Software (GeoGebra and e-Transformation) phase; 3) Integrated teaching and learning phase using each software and a Learning Activity Module; and 4) the Post Test phase. Purposive sampling was used to select the three classes of Form two students from a school. These students were randomly assigned into two groups, whereby group one followed the GeoGebra mode of learning and the second group used e-transformation. The total number of students in group one was 40 students, and group two was 30 students. The data were analyzed using SPSS.

4 Results

A. Effects of GeoGebra on Performance score for pre and post test.

For the group that used GeoGebra, the analysis on the performance scores for pre and post tests were by using Wilcoxon T. Research findings indicated that there was significant difference in performance scores for the post test (Mdn = 31.00) compared to the pre test (Mdn = 25.00), z = - 2.85, p = .004 < .05, r = -0.45). The results showed that students who learned transformation using GeoGebra showed increase in their performance after they used it. However, the effect size was medium [2].

B. Effects of e-transformation on Performance score for pre and post test.

For the second hypothesis, analysis using Wilcoxon T showed that there were significant differences in post test performance scores (Mdn = 25.00) compared to the pre test scores (Mdn = 20.00), z = - 2.76, p = .006 < .05, r = - 0.50). This showed that the e-Transformation could help students to increase their performance. Meanwhile, the effect size was big [2].

C. Effects of GeoGebra and e-transformation on Overall Performance score for pre test

To answer the third hypothesis, the Mann-Whitney test was conducted on pre test performance scores for the GeoGebra group (Mdn = 25.00) compared to the e-transformation group (Mdn = 20.00, U = 478.00, z = 1.45, p = .147 > .005, r = 0.173) and the effect size was small [2]. This showed that based on the pre test, students from both groups were at the same level.

D. Effects of GeoGebra and e-transformation on Overall Performance score for post test

Next, for the fourth hypothesis, the Mann-Whitney test was also conducted on the post test performance scores for the groups that used GeoGebra and e-transformation. Findings also indicated that there was no significant difference in post test performance score for the GeoGebra group (Mdn= 31.00) compared to the e-Transformation group (Mdn= 25.00, U = 494.00, z = 1.262, p = .207 > .005, r = 0.15) and the effect size was small [2]. This finding also showed that students who used GeoGebra and e-transformation did not differ significantly on the post test.

E. Effects of GeoGebra and e-transformation
on each of the topics (transformation, reflection and rotation) tested

More detailed analysis was also conducted according to each topic in the post test. Three topics tested were on transformation, reflection and rotation. For this purpose, the Mann-Whitney test was conducted. Research findings indicated that for the transformation topic, there was no significant difference in performance scores for the GeoGebra group (Mdn = 11.00) compared to the e-transformation group (Mdn = 7.00, U = 483.50, z = -1.407, p = .159 > .005, r = 0.17). For reflection, the Mann-Whitney test analysis did not show any significant difference in the performance score for the GeoGebra group (Mdn = 15.50) compared to the e-transformation group (Mdn = 14.00, U = 538.50, z = -.767, p = .443 > .005, r = 0.09). As for rotation topic, findings also indicated that there was no significant difference in performance scores for GeoGebra group (Mdn = 7.00) compared to the e-Transformation group (Mdn = 3.50, U = 472.00, z = -1.543, p = .123 > .005, r = 0.18). Thus, these findings showed that each topic included in the post test did not show any significant difference in terms of the students’ performance scores. Students who used e-Transformation and GeoGebra had the same skills when answering questions related to transformation, reflection and rotation.

5 Discussion
The integration of mathematical software in teaching and learning is important due to its ability to do quick calculations and also helping students to visualize difficult mathematical concepts. Various mathematical software available are like Mathematica, Maple, Geometers Sketchpad, Autograf and others. Teachers need to purchase this software if they decide to use it. However, the existence of mathematical software in the form of open source software can resolve this problem. There are many open source mathematical softwares which can be downloaded for free from various sites on the Internet. The abilities and effectiveness of these softwares have not yet been explored. In addition, researchers or educators can decide to develop their own software for their use.

In this study, we have used GeoGebra as a form of open source software and also software developed specifically for the purpose of the study (e-transformation). Students who used the GeoGebra software and e-transformation showed improvement in performance when comparing the results of the pre and post tests scores of both groups. This showed that the use of technology can have a positive effect on student achievements. However, findings did not show any significant difference between students who used the GeoGebra software compared to the e-transformation group. Similarly, further analysis carried out based on each topic on the post test scores also did not show any significant difference for the topics on transformation, reflection, and rotation. Findings of this study matched the study conducted by [1], [3], [6], [7] and [9].

6 Implication of the study
Technology is essential in teaching and learning mathematics. The result of this study could have an implication on the teaching and learning of mathematics in schools. This study shows that there is improvement on student achievement for students who are using open source software and those using a self-developed courseware. However, it does not show any evidence that state which software is better. Further studies need to be undertaken to identify other factors that the integration of technology in teaching and learning of mathematics can benefit educators and students.

7 References:
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