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Effect of Using Geogebra on Eight Grade Students' Understanding in Learning Linear Equations

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Abstract: *GeoGebra is a dynamic geometric software developed for the support of mathematics teaching. The aim of this research was to study the effect of GeoGebra on mathematics achievement in relation to the linear equations and explore the perception of students towards the use of GeoGebra in teaching mathematics. Forty students were participating in this quasi-experimental study in which one group was assigned as experimental and another as control group. Data were collected by using self-constructed tools and analyzed by using percentage, mean, standard deviation and t-test as well as effect size was calculated. The result from the study revealed that the achievement of GeoGebra instructed students was significantly higher than the control group. Additionally, level of perceptions of experimental group students found to be high towards the use of GeoGebra. Hence teachers should use this software while they instruct graph of linear equations in their lessons and curriculum developers and textbook writers should incorporate such kind of activities into the curriculum and textbooks.*

Keywords: GeoGebra, mathematics teaching, achievement, perception, effect, Nepal

INTRODUCTION

Mathematics is compulsory subject in school level in Nepal. Set theory, arithmetic, mensuration, algebra, geometry and statistics related content have been included under the curriculum of basic level (class 1-8). Linear equation is under algebraic portion. Many types of digital tools have developed for the support of mathematics teaching and learning, and GeoGebra is one of them. GeoGebra represents dynamic geometric software (Zengin et al., 2012)which is applicable and important for mathematics teaching. In this regard this experimental study focused on the use of GeoGebra in teaching linear equation at eight grades.

Mathematical digital tools are very convenient for effective, creative, collaborative and self-learning (Joshi, 2017). Digital resources encourage the learners towards multi-way of learning and supports to mathematical modeling, visualize mathematical shapes and figures. Concept of self-learning, technological based learning and artificial intelligence are modern pedagogical terms which are in practices in present context. GeoGebra is effective in teaching definite integrals (Tatar

& Zengin, 2016), function (Zulnaidi & Zakaria, 2012), triangle (Dogan & Icel, 2011; Ozcakır et al., 2015), arithmetic (Kamariah et al., 2010), circle (Shadaan & Eu, 2013; Tay, 2018), trigonometric function (Ibrahim & llyas, 2016), derivative (Ocal, 2017), geometry (Jelatu, Sariyasa, & Made Ardana, 2018), fraction (Bulut et al., 2016), geometry (Kushwaha et al., 2014), trigonometry (Zengin et al., 2012), analytic geometry (Khalil et al., 2018), coordinate geometry (Saha et al., 2010), statistics (Emaikwu et al., 2015) and differential calculus (Diković, 2009). These studies show that GeoGebra is highly applicable and important tool for mathematics teaching yet, they have not addressed the issues of linear equations which is the focus of this current study.

In the context of Nepal, application of GeoGebra have formally integrated in the curriculum of ICT in Mathematics Education in B. Ed and M. Ed. in Mathematics Education of Tribhuvan University Nepal. It has incorporated in short-term training programs of teacher training. There should be deep thinking about using GeoGebra application in linear equation teaching and how it effects in teaching linear equation? What is the perception of the students about the GeoGebra? This study will justify and find the answer of these inquiries.

OBJECTIVES

The main concern of the study is the study of effect of GeoGebra on the mathematics achievement in relation to linear equation and to explore the perception of learners towards the effectiveness GeoGebra in mathematics learning.

METHODOLOGY

Materials and Methods

Quasi-experimental research design was used for the research. All the students of class eight (two groups) from Heartland Academy Kathmandu Nepal were assigned for the study. Both groups of the students were separated by school administration based on rule of the school containing 20 students in each group. Students were blind about the experiment. Additionally, the students of both groups were unaware about the GeoGebra software before the experiment. Experimental group and control group were declared by queen toss.

Groups	Pre-test	Treatments	Post-test
Experimental	Q1	GeoGebra assisted teaching	Q2
Control	Q3	Traditional teaching	Q4

Table 1 Design of the study

Where, Q1=Pre-test given to experimental group, Q2=Post-test given to experimental group, Q3=Pre-test given to control group and Q4=Post-test given to control group

Study Setting and Sampling

Self-constructed tool "Achievement test' was implemented for pre-test and post-test. Where pre-test contain 10 and post-test contained 20 multiple choice items. Additionally, “Perception Scale” was implemented for the perception of students in experimental group. On the basis of national curriculum of mathematics, the unit was taught 10 days to both groups. On this regard ten episodes were developed for experimental group. Validity of tools were measured by content validity based on the suggestion of subject experts.

GeoGebra has several features like as animation, transformation of objects, calculation and graphical representation of 2D and 3D figures, algebraic, exponential, logarithmic and trigonometric functions. The problems related to equations solving, limits, derivative integration, probability and statistics can also be solved and visualized by this software. However, the main concern of this experiment was to teach linear equation at grade 8 hence the some examples related to concepts of linear equation used in experiment are given in Figure 1 to 4.

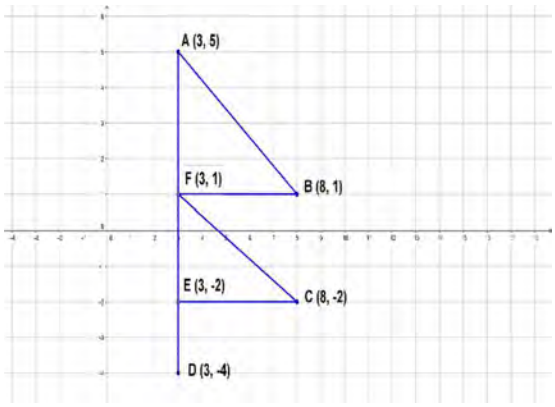

Figure 1 Graph showing vertices of the figure in GeoGebra

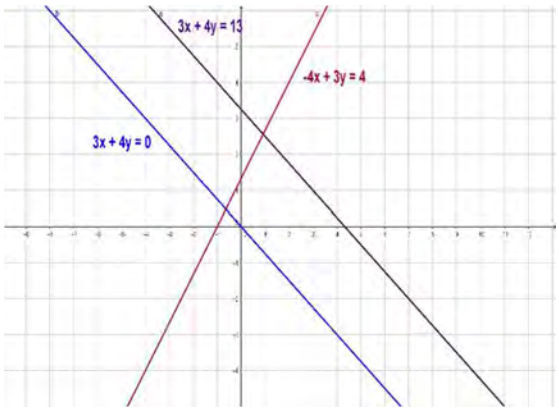

Figure 3 Graph of parallel and perpendicular lines in GeoGebra

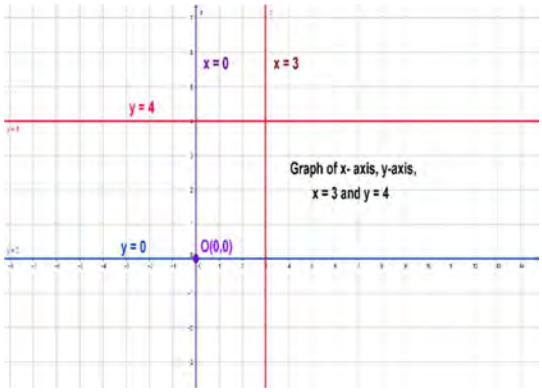

Figure 2 Graph of axes and the lines parallel to the axes

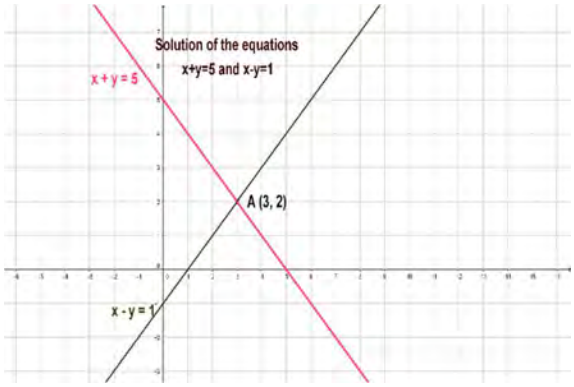

Figure 4 Graph of the equations x – y = 1 and x + y = 5

Definition of Variables

In this research, use of GeoGebra is independent variable and mathematics achievement and perception of students are considered as dependent variable.

Statistical Analysis

Two independent sample t-test was calculated to determine the significant different of mean score between two groups while percentage, mean and standard deviation were calculated under descriptive statistics. Additionally, effect size was calculated by using Cohen's d formula for the accurate difference between groups.

RESULTS

Table 2 showed that experimental and control group have no difference in mean score of mathematics achievement. Which indicates that the groups were homogenous based on the average achievement score on pre-test.

Groups	Sample	Mean	S.D.	p-value
Experimental	20	6.95	2.09	0.94
Control	20	7.0	1.95	

Table 2 Independent sample t-test result on pre-test between the groups

Table 3 showed that the significant difference was found on achievement scores between experimental and control group students in favor of experimental group and effect size (d=0.82) found to be high. Which indicated that the GeoGebra is best tool for teaching linear equation at school level.

Groups	Sample	Mean	S.D.	p-value	Effect size
Experimental	20	16.60	2.26	0.02*	0.82
Control	20	13.80	4.30		

Table 3 Independent sample t-test result on post-test between the groups

*p-value <0.05 (i.e. Significant)

Perception of Students Towards the Use of GeoGebra

After completing the experiment, students' perception was measured by experimental grouped students. A tool having nine items were used to determine students' perception towards the use of GeoGebra in linear equation and overall mathematics. All items were in the form of Likert scale as strongly disagree to strongly agree. The scoring technique is 1 for strongly disagree to 5 for strongly agree for positive items and reverse scoring in negative items.

Table 4 showed that the level of perception of students towards the use of GeoGebra in teaching linear equations found to be high. The result also indicates that the software is helpful to learn mathematical concepts, visualize mathematical content and make students more creative, enjoyable and confident. Additionally, it is essential and important for mathematics learning.

Items	Percentage					Mean	S.D.	Level
	SA	A	N	D	SD			
I like GeoGebra while learning linear equation	45	50	5	0	0	4.4	0.59	High
GeoGebra helped me a lot to learn the mathematics concept	45	40	15	0	0	4.25	0.78	High
GeoGebra is essential and important for learning Mathematics	0	80	20	0	0	4.0	0.64	High
GeoGebra software helps easy to understand Mathematical problems	5	90	5	0	0	4.0	0.32	High
I felt confident to solve problems using GeoGebra.	30	40	25	5	0	4.0	0.85	High
GeoGebra helps to make me more creative	25	60	15	0	0	4.1	0.64	High
I enjoyed learning mathematics much more using GeoGebra.	20	75	5	0	0	4.05	0.82	High
GeoGebra helps to visualize mathematical content	10	75	15	0	0	4.0	0.45	High

Table 4 Perception of students towards the use of GeoGebra in mathematics learning (n=20) *(SA- Strongly Agree, A-Agree, N-neutral, D- Disagree, SD- Strongly Disagree and S. D. - Standard Deviation)*

DISCUSSION

The findings of this research indicate that GeoGebra is a very good tool for teaching linear equations. The finding indicated that the implication of GeoGebra in linear equation instruction has significant effect on students' achievement. Similar result were found by Tatar & Zengin (2016) in teaching definite integral among perspective secondary teachers in Turkey, Zulnaidi & Zakaria (2012) in teaching function among high school students in Indonesia, Ozcakır et al. (2015) in teaching triangle, Kamariah et al. (2010) in teaching arithmetic among secondary students of Malaysia, Shadaan & Eu (2013) in achievement nine grade students in teaching circle, Ibrahim & llyas (2016) in teaching trigonometric function at public high school in Istanbul, Arbain & Shukor (2015) in achievement on mathematics learning in Malaysia, Omer & Ozturk (2013) in in academic achievement, Bulut et al. (2016) in teaching fraction at primary level, Kushwaha et al. (2014) in teaching geometry to secondary level, Zengin et al. (2012) in achievement in teaching trigonometry, Khalil et al. (2018) in in teaching analytic geometry in class 11, Tay (2018) in teaching theorems of circle among senior high school students, Saha et al. (2010) in achievement on coordinate geometry teaching among low visual-spatial ability students, Emaikwu et al. (2015) in teaching statistics among secondary school students of Benue state. Additionally, the effect size found to be high in favor of experimental group (d=0.82). The finding of the study showed that

GeoGebra is highly applicable tool for teaching Linear Equation whereas literature verified that the tool is very good for teaching several dimensions of mathematics.

The participants highly agreed that the Geogebra is a very good tool for learning mathematics, understand mathematical concepts, increase their confidence in solving problems, make them more creative, make learning more enjoyable and visualize mathematical content. Similar result were found by Shadaan & Eu (2013) and Arbain & Shukor (2015) in perception of students. Dikovic (2009), Ocal (2017) and Zulnaidi & Zamri (2017) showed that the tool is very good for developing conceptual understanding. Additionally, Lavicza & Prodromou (2017) and Wah, Kewangan, & Takaful (2015) showed that it is good resource for student attitude, attribute on attention, relevance and confidence. Hence the study verifies that GeoGebra is very good tool for students conceptual understanding and visualized the mathematical contents.

CONCLUSION

GeoGebra is a good tool for teaching linear equations and has a significant effect on students' achievement in linear equations. GeoGebra instructed classroom students were agreed that the software is decent for learning mathematics, understand mathematical concepts, increase the confident, make them more creative, make learning more enjoyable and visualize mathematical content. The research was limited to small group of students of class eight so additional research is needed to different classes in similar content. The finding of the research suggested to all mathematics teachers that this software is highly beneficial and applicable to students' achievement enhancement and conceptual understanding. Therefore, teachers have to use this software while they instruct the graph of linear equations in their lessons. In addition, it is recommended that the curriculum developers and textbook writers should incorporate such kind of activities which are based on dynamic mathematics software into the curriculum and textbooks for the graph of linear equations and other content.

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