GeoGebra from Students' Perspectives

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Abstract: Traditional methods of teaching and learning are still dominant in Nepal. Normally, teachers distribute knowledge and skills to their students who in turn memorize facts, definitions, and algorithms. The paper- pencil method has a dominant role as a mathematical tool. Technology has a minimal to nonexistent role at schools in Nepal. Very few schools have access to technologies, and even fewer integrate them in teaching and learning mathematics. In an effort to provide an opportunity in the present situation, the Dynamic Geometry Software: GeoGebra was integrated to teach reflection and rotation of high school geometry for ninth grade students. The data indicated that students were enthusiastic and motivated to learn mathematics with the help of GeoGebra. The analysis of data also revealed that GeoGebra provided more practical and visual approaches of learning mathematics. It also helped to minimize memorizing the algorithms and formulas, and provided more conceptual understanding of mathematics.

Keywords: Methods; GeoGebra; Dynamic Geometry Software; Maths

1. Research Background

Nepal is a developing country which is still behind in employing technology for teaching and learning mathematics. The government of Nepal emphasizes integrating technology in teaching and learning mathematics (MOE, 2007). However, in practice there appears to be little or no encouragement of students to explore mathematical ideas and concepts that they are expected to know. The paper-pencil method has a dominant role as a mathematical tool. Technology has a minimal to nonexistent role at schools in Nepal. Very few schools have access to technologies, and even fewer integrate them in teaching and learning mathematics. In fact, the school-educational system is based on a traditional approach with emphasis given to drill-and-practice and procedural fluency (Bajrachraya, Bhuju, & Pokharel, 2006).

2. Aim of the study

In an effort to provide an opportunity in the present situation, probably the first time in the country, the researcher taught ninth grade students (14/15 years) with the help of Dynamic Geometry Software (DGS): GeoGebra in 2009. One of the purposes of the study was to investigate how students think and understand about GeoGebra, which had never been integrated in their mathematics lessons. The aim of this study was also to let teachers and students know about the free mathematical software: GeoGebra.

3. Dynamic Geometry Software

The importance of using technology in mathematics education has been emphasized by the National Council of Teachers of Mathematics (NCTM) because technology can have a crucial role in teaching and learning mathematics: it both influences the mathematics that is taught and enhances students' learning (NCTM, 2000). For example, Dynamic Geometry Software (DGS) offers new tools that are unavailable in paper and pencil, so DGS widens the range of accessible geometrical constructions and solutions (Straesser, 2001).

Dynamic geometry software enhances the discovery learning process by enabling the user to explore many more examples on the computer screen than could be performed reasonably with pencil and paper. In addition, DGS such as GeoGebra is an easy-to-use tool for learning and teaching mathematics (Hohenwarter & Preiner, 2007). An important advantage of public domain or open source software (GeoGebra) is that there is no extra financial outlay for schools (or individual teachers and students) to acquire it, which is very important for the developing countries such as Nepal. So, students can use it at home and explore their ideas in the absence of their teachers. Learning mathematics in a GeoGebra environment, students remain engaged with the interactive features that GeoGebra brings, such as learning from feedback, seeing patterns, making connections, and working with dynamic images (Edwards & Jones, 2006). Moreover, GeoGebra provides an opportunity for visual images of various mathematical ideas and concepts, which enhances learning mathematics (Green & Robinson, 2009).

4. Methodology

4.1. Research Design

A qualitative research design was chosen for this study where 42 students were participated in this study; however, data was collected from only two students. The qualitative data was based on an interview and classroom observations.

4.2. Mathematics Lessons

In general, the number of students at a classroom in Nepalese high schools ranges from thirty to fifty, and sometimes even more. Forty two students were participated in this study. There were enough desks and benches in the classroom so that all students could sit and have a work desk. The classroom could accommodate as many as fifty students. Classrooms, normally, do not have computers and projects; thus, the researcher rented a beamer and used his own laptop for the lesson activities in order to display them for students. The researcher hung a cotton sheet as a screen on top left hand part of the blackboard in the classroom, so that the researcher could still write on the right part of the blackboard.

Figure1: A vignette of a lesson in a classroom

The researcher taught six lessons (50 minutes) about reflection and rotation from a geometry course in a school day for a week (six days). The researcher used GeoGebra extensively to teach reflection and rotation. Several examples of reflection and rotation were provided in a dynamic way with the help of GeoGebra in order to provide opportunities for students to explore reflection and rotation. At the end of the six lessons, students were provided opportunities to learn and explore more about reflection and rotation in a computer laboratory. Students were asked to complete six activities pertaining to reflection and rotation with the help of GeoGebra. There were 25 computers and a marker board in the computer laboratory. There were 42 students at the time of the practical session. This meant that one computer for two students was enough. One day before the practical session, the researcher installed the software *GeoGebra* on all computers. The installation was done in such a way that the students only had to click on the GeoGebra icon to start the program and to open the GeoGebra window where students paired themselves up and worked on the activities in the computer laboratory.

Figure 2: A vignette of computer laboratory session

4.3. Data Collection

At the end of the computer work session, the researcher asked students to participate (one male and one female) in an interview. The researcher briefly informed students that the interview will be about their experience, impression, and understanding about the use of GeoGebra for teaching and learning of mathematics. After having discussion for a while, students were able to provide the names of two students who were involved in the interview process. The audio-taped recorded interview was conducted for a half hour based on the questionnaires that the researcher had designed in advance. After finishing the interview with the female student, the interview for the male student was conducted. The interview questions contained ten questions, most of which were related to students' impressions, experience, and understanding about GeoGebra in connection to learning reflection and rotation in particular, and mathematics in general.

4.4. Data Analysis

The analysis, particularly the audiotape interview, was carried in a number of steps. The audiotape interviews were carefully transcribed word by word. Glesne (2011) recommends that the researcher starts a codebook soon after the data collection starts. The researcher kept track of all the data collected; however, the code book was developed during data analysis. In fact, coding is a progressive process of sorting and defining and defining and sorting of collected data (Glesne, 2011). After a couple of times of modification and refinement of coding, finally four major themes emerged. The themes were practical approach, visual, less memorizing, and fantastic.

4.5. Validity, Verification and Ethical Issues

Glesne (2011) stated that the one way to address the validity issue is the prolonged engagement and persistent observation. The researcher taught geometry lessons for a week, observed students' engagement in the classroom as well in the computer laboratory, and conducted an interview. Engaging for a sufficient amount of time in the field helps to make the finding more valid in this qualitative study. Furthermore, the three types of data— teaching in the classroom, observing the students' work in the computer laboratory, and conducting interviews—helped to triangulate and verify the findings reported in this paper.

The researcher explained about this study and its purpose before requesting participants to be involved in this study. Glesne (2011) stated that potential study should inform participants that participation is voluntary and they may freely choose to stop whenever they want. All participants, in this study, were informed that the participation was voluntary, they may freely choose to stop at any time, and participating in this study did not affect any aspects of their well-being.

4.5. Findings

The findings will be reported on the basis of the codes and themes that emerged during the data analysis phase. The major themes that emerged during the data analysis were practical approach, visual, less memorizing, and fantastic.

Students refer to the teaching and learning with help of GeoGebra as "the computer method" and the traditional teaching and learning approach as "the blackboard method."

> "Learning with the computer method was easier for me than the learning via the blackboard method because we have to buy the notebook (graph paper) and plot the coordinate's points very roughly on paper and it was very hard for me. But in this computer method, it was very easy to plots coordinates points, and reflects and rotates them on the coordinate plane with the help of GeoGebra software". –male student

It is worthwhile to mention that teachers used blackboard and chalk while teaching mathematics in the classroom because this was what available in the each classroom. Students preferred to use a computer method or practical approach of learning of mathematics when they integrated GeoGebra. The fact was that students were engaged in doing mathematics in a computer laboratory, so that they called it a practical approach. The female student stated that "Many mistakes could be made while doing reflection and rotation in the blackboard method, but in the computer method it was easy to learn."

Both students contended that the software provides visual representation. They stated that we could see changes in the images and objects in the GeoGebra window when the geometrical objects were reflected and rotated. Therefore, the computer method was helpful to understand reflection and rotation. The male student stated that "the computer method was helpful to give visual images of the objects, so it was easy to understand the reflection and rotation." One of the benefits of the computer method that students stated was that they could immediately see the mistakes that they had made, which was not possible when tasks were done by pencil and paper.

The data also revealed that the computer method was completely new for the students; they had been accustomed to learn in traditional ways. Therefore, sometimes it was difficult for students to cope with the new setting. It was more an initial feeling of insecurity.

The female student was of opinion that "the computer technology is beyond the capacity of our nation, but you have provided us a chance to learn through the computer." Though it was for short period we got chance to learn with a new method and we got new ideas and experiences." This quote illustrates that there were amongst the students a feeling that no one, not even the poor people, should be left behind in the beginning age of computer technology in Nepal. Furthermore the male student stated that information and availability of this software should be known not only at schools in Kathmandu but also throughout the country. The data also indicated that students never imagined that there is such a nice mathematical tool that can be used for learning mathematics in dynamic ways.

The data also revealed that GeoGebra helped greatly. Participating students believe that the software was a great mathematical tool through which students do not have to memorize the formula for which students normally do in the examination. Students think that GeoGebra was fantastic because it provides a depth understating of reflection and rotation so that they did not have to memorize the formulas. Normally students do not get a formula-worksheet during the examination period; they have to memorize formulas in a blackboard-chalk teaching method.

5. Conclusions

Students preferred to use computer method when learning mathematics when they utilized GeoGebra to complete reflection and rotation tasks. The computer method was completely new for students; they had up to then only been exposed to the traditional method. Therefore, sometimes it was difficult for students to cope with the new setting. It was more an initial feeling of insecurity. It was found that students were enthusiastic learning mathematics with the help of GeoGebra. The various aspects of GeoGebra such as visuality, dynamic in nature help students to provide more depth understanding of mathematics as contended by Straesser (2001), Green and Robinson (2009), and Hohenwarter and Preiner (2007). The immediate feedback that students received with the help of GeoGebra was of great advantages because students did not get similar advantages with the pencil-paper environment as stated by Edwards and Jones (2006). Students even said that they will use this software at their home because GeoGebra is free software. Students were very much impressed and were excited to know about the software. They also emphasized in publicizing information about the software throughout the country. It appeared that GeoGebra can be a useful mathematical tool that can be integrated for teaching and learning of mathematics at high schools in Nepal.

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