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Employing Geogebra in the teaching of mathematics: the teachers' perspective

Hutkemri, Effandi Zakaria and Norazah Mohd Nordin
Faculty of Education, Universiti Kebangsaan Malaysia.

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ABSTRACT
The purpose of this study was to investigate teachers' perceptions about employing GeoGebra in the teaching and learning of mathematics. The study comprises four respondents who are currently enrolled in a mathematics education course at Universiti Kebangsaan Malaysia. The findings indicate a similar opinion among the respondents according to their experience, with regard to GeoGebra. All respondents agree that the software employs straightforward and comprehensible instructions in addition to offering accurate and simple information. They also agree that the software is user friendly. The respondents on the whole have positive opinions regarding the idea of employing GeoGebra in the teaching of mathematics.

Introduction

The utilization of new technology in the 21st century is a challenge for mathematics educators. The use of technology has a huge impact on human life, especially in the educational setting. Most of the countries in the world are encouraging the use of technology in the teaching and learning process. The utilization of technology in the teaching of mathematics can assist students to acquire the basic skills of mathematics. Therefore, teachers should be given the opportunities and support with relevant practices to help them improve their skills in exploring the potential of information technology. They should be guided in the application of the latest technological devices in the various solutions of mathematical problems (Oldknow & Taylor, 2000). The guidance that has been given to the teachers should be supported by various authorities in order to make sure that the teachers and students are involved in the integration of technology in the teaching and learning of mathematics.

The integration of technology is a continuing process in mathematics education, regardless of the level of the students. The integration of technology in the teaching and learning of mathematics should be planned and arranged thoroughly for effective teaching. NCTM (2000) recommended the use of technology by well-informed teachers in order to support mathematical understanding. The teacher who is also the facilitator has to make sure that the teaching and learning environments are conducive for the students. Teachers should have a good lesson plan and prepare all the teaching materials before going to class. Teachers should clearly understand the content, pedagogy, and how to integrate technology in the teaching and learning of mathematics. It is important for the teachers to have knowledge of integrating these different fields (Niess, 2006). The integration of technology in the teaching and learning of mathematics brings about new and innovative discoveries. However, these discoveries will be effective only if it is supported by technology appropriate for the students.

Teachers should be ready to accept current changes and make an effort to make technology a reality in the classroom. The use of technology in the teaching and learning of mathematics should be given serious attention by educators. Mathematics educators should make mathematics an interesting subject in order to attract students to learn the subject and at the same time focus on the important concepts in mathematics. Other than enhancing mathematical skills, using technology can also have a positive impact and provide opportunities to learn and understand. The students will also be supplied with knowledge to compete and function in the world of high technology. It is the responsibility of educators to create a bright future for students in facing the world, which depends on mostly mathematics, science, and technology (Furner & Marinas, 2007).

The utilization of technology in industry has given the opportunity for educators to use technology in the teaching and learning process (Ahmad Fauzi et al. 2009). The existence of computers in the classroom can have a huge impact on the teachers. The teachers are no longer teaching by using traditional methods, but they are now acting as facilitators. The teachers should be able to use the computer in order to create an environment for effective teaching and learning. The utilization of computers in the mathematics classroom can provide better teaching and learning compared to the traditional method (Norazah & Effandi, 2007). For that reason, the teachers should be trained in using technology in order to make sure that the learning process becomes effective. In addition, the priority must be on the readiness of the teachers in using technology. Teachers must be proficient in using technology in order for teaching and learning to be effective.

GeoGebra is an open source software for mathematics teaching and learning that offers geometry, algebra, and calculus features (Hohenwarter, 2008). This software can be downloaded for free from the official web page of GeoGebra (www.geogebra.org), and it is compatible with any platform, namely, Windows, Macintosh, Linux, and UNIX (Grandgenett, 2009). GeoGebra is useful because it covers the planning activity, delivery activity, guiding activity, and assessment activity. This software is an exploration tool and can create a new dimension in learning mathematics. Employing GeoGebra as part of mathematics teaching methods is highly encouraged, particularly for those emphasizing exploration, hence resulting in a better understanding of mathematical concepts among the students. One of the factors that determine the success of the

Tele:
E-mail addresses: effandi@ukm.my

learning process is the methods and strategies used by the teachers. By using GeoGebra teachers can actively involve students in the learning process. The skills of utilizing GeoGebra can be improved by practicing it regularly either with the teachers or students. Teachers should be encouraged to use GeoGebra in the teaching and learning of mathematics because it is particularly useful in developing a good learning environment. This is due to the fact that the students are exposed to simulation, thus helping them render the idea to reality more accurately. Hohenwarter (2008) asserted that the software is an excellent tool for teaching calculus. Haciomeroglu et al. (2009) further asserted that GeoGebra's features have the capacity to improve the teaching process of geometry, algebra, and calculus.

There is a dearth of research that has been done related to the utilization of GeoGebra in the teaching of mathematics. According to Kamariah et al. (2010), the use of open source software in teaching and learning is still new in Malaysia. Rincon (2009) conducted a study on the usage of GeoGebra in teaching geometry, algebra, and calculus. In his research, he asserts that the students' understanding of the concepts in geometry, algebra, and calculus could be easily achieved. Another study, by Kamariah et al. (2010), found a significant difference between pre- and posttest scores of the group using GeoGebra. However, there was no significant difference in performance scores of the posttest. Edwards and Jones (2006) stated that GeoGebra is useful to explain geometry and algebra problems. Antohe (2009) also stated that GeoGebra is an effective tool to assist the learning process and explained that the software could also be used to solve arithmetic, geometry, and algebra as well as calculus problems. Antohe concludes that GeoGebra is an efficient tool for e-learning. The utilization of GeoGebra can help students visualize abstract concepts and know the relationship in mathematics. The ability to solve mathematical problems by using electronic tools can increase the students' interest in mathematics as well as increase their cognitive abilities. Haciomeroglu et al. (2009) noted how GeoGebra can be used as a tool in teaching and learning, for example, describing a linear or quadratic function and its inverse simultaneously, planning the mobile phones' cycle, learning of linear functions in real life, and sketching of triangle prism. This research seeks to examine teachers' opinions about employing GeoGebra in the teaching of mathematics

Materials and Methods

A total of four respondents participated in this study. The selected respondents possess different amounts of teaching experience. In this research, the respondent's nickname is employed for the purpose of easy identification. The four respondents were given time to explore the software. A laptop was installed with GeoGebra, and all respondents tested the software by using the same laptop. An open-ended type of interview was conducted, and the responses were noted in order to build a database comprising the respondents' evaluation of the software. The research respondent profiles are as follows in Table 1.

The first respondent is known as Iis. She possesses five years of experience in working as a teacher. She holds a degree in mathematics education and is currently undergoing a master's program. The second respondent is known as Susi. She has five to ten years of experience, and she holds a degree in and is currently undergoing a master's program in mathematics education. The third respondent is known as Zakir. Zakir has a teaching experience spanning five to ten years. He holds a degree and is currently enrolled in a master's program in mathematics education. The fourth respondent is Putri. She has an experience of teaching for more than ten years. She currently holds a master's degree and is enrolled in a doctoral program in mathematics education.

Results And Discussion

As shown in Table 2, the responses disclose several results. The respondents discovered that the instructions are rather simple and straightforward. This is evidently displayed in the form of appropriately used symbols and the simple language used in the toolbar. In addition, the information displayed is fairly simple and straightforward, too. In the opinion of the teachers, they believe that instructions in GeoGebra are clear. There is no confusion for the teachers with regard to reading and understanding. Information is displayed in a simple and straightforward way and arranged sequentially, as we may find in the general mathematics curriculum, thus allowing the respondents to fully utilize the software. This software also fulfils the teaching objectives, and it helps respondents to describe, for example, the concept of a circle, in a rather entertaining approach.

On the basis of the respondents' opinions, it can be summarised that GeoGebra can be used in the teaching and learning of mathematics in school. Other than that, the technique of presenting information produced by GeoGebra is very clear and concise as well as structured. Other than the attractive presentation technique, the respondents also believe that the content of GeoGebra can also attract people to use the software in the teaching and learning of mathematics. The respondents showed interest in using GeoGebra in order to explain concepts and procedures in mathematics.

Overall, the respondents found the software easy to use, and they found almost no difficulty in navigating through the software. It is apparent that the respondents require just a little amount of time in order to master the software.

GeoGebra allows them to fully explore the software without restrictions. The respondents reported that the text sizes are appropriate and hence allowed easy reading. The respondents also stated that the color scheme and animation are appropriately used. The respondents also found the instruction given is easy to remember, and the button applications function well. No problems were encountered during the test run of the software. The respondents also found that the display screen is consistent. The respondents are also well versed in the software's layout, which helps them concentrate more on the teaching. The layout of GeoGebra also inculcates interest in the teachers and students alike. In line with the opinion of Antohe (2009), GeoGebra allows the students to grasp abstract concepts, be able to relate, and learn about mathematics. Geobra is able to grab student attention to mathematics as well as improve students' cognitive abilities.

The respondents also claimed that the software made the teaching of geometry, algebra, and calculus easier. Therefore, it is appropriate to employ the software in the teaching of geometry, algebra, and calculus. This is in line with the opinion of Haciomeroglu et al. (2009). He also stated that the usage of the software accommodates the teaching of geometry, algebra, and calculus. The positive opinions of the teachers about GeoGebra were consistent with previous findings by Haciomeroglu et al. (2009), Antohe (2009), and Rincon (2009). It can be concluded that GeoGebra is a useful software that can

be utilized in the teaching and learning of mathematics in schools.

Conclusion

It can be clearly seen that the respondents are generally of the same positive opinion regarding employing GeoGebra in the teaching and learning of mathematics. The respondents describe the software's instructions as rather straightforward and clear. As for the technical aspects, the respondents assert that the software is easy to handle and has an appropriate animation display as well as excellent function buttons. The respondents clearly suggested the usage of such software as a teaching tool in the mathematics classroom.

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Table 1: Profile of the research respondents

Respondents' Nom de Plume	Experience
Iis	<5 years
Susi	5–10 years
Zakir	5–10 years
Putri	>10 years

Table 2: Respondents' responses

Respondents	Experience	Response
Iis	<5 years	Interestingly, GeoGebra is an exciting tool to be used in the teaching and learning process. GeoGebra improves students' conceptual understanding. Besides, it looks good graphically. I am also attracted to use this software because the design command tool is comprehensible to both teachers and students. In my opinion, GeoGebra helps the students to enrich their understanding of the basic concepts of a topic. GeoGebra basically helps consolidating basic concepts.
Susi	5–10 years	GeoGebra is an exciting tool. Besides geometry, GeoGebra is particularly useful for algebra and calculus as well. The software's working layout is good, and in some way, it encourages the users to explore. Besides, it is easy to learn and use. In my opinion, GeoGebra helps teachers and students alike in the process of teaching and learning. The color scheme and animation contribute to the students' interest in exploring the software and simultaneously inculcate the students' enthusiasm about learning mathematics.
Zakir	5–10 years	I have tried GeoGebra previously. It is free and readily available online to be downloaded. GeoGebra assists teachers and students in the teaching and learning process. The language command used is simple, and the display is visually pleasing.
Putri	>11 years	GeoGebra helps teachers in the teaching and learning process tremendously. It helps both teachers and students alike to understand subject concepts more easily. The text layout, graphics, and appropriate animation contribute to its effectiveness. Besides, the language command used is comprehensible and clear. GeoGebra usage should be encouraged without compromising the teachers' role in the process of teaching and learning.