THE EFFECTIVENESS OF USING GEOMETER'S SKETCHPAD (GSP) IN THE TEACHING AND LEARNING OF MATHEMATICS IN A MALAYSIAN TECHNICAL SCHOOL

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ABSTRACT

The purpose of this study was to determine the effectiveness of an interactive geometry software program, Geometer's Sketchpad (GSP), in the teaching and learning of mathematics among technical schools' students. The quasi-experimental study was conducted on 56 students from a randomly selected technical school. The students were assigned into a controlled and an experimental group using cluster (class-based) random sampling. The control group received conventional teaching method while the experimental group was taught using a GSP module on a chosen topic namely Trigonometric Functions for the duration of 8 weeks. Three sets of tests, which are pre-test, post-test and retention-test were administered to both groups of students in weeks 1, 8 and 10, respectively. Besides the tests, a set of questionnaires and an interview protocol were used in collecting the empirical data. The results of tests and questionnaires were analysed using descriptive and inferential statistics such as mean, standard deviation and independent t-test. The findings indicated that there were improvement in the mean scores for both groups, with the experimental group gained significantly higher. The result of the retention-test showed that retention ability of knowledge acquired by the experimental group was significantly better compared to the control group. Thus, the study concludes that the use of GSP as a tool in the teaching and learning of mathematics has improved the students' achievement and retention ability. In addition, the students and the teacher have demonstrated positive attitudes and enthusiasm in this new learning approach. The findings also supported the theories and models used in the conceptual framework of this study. The implication derived from the study is that GSP can be utilised as a very effective tool to enhance mathematics teaching and learning. Finally, the study recommends that the ministry should be devising an effective way to secure teachers' commitments in using GSP in teaching mathematics especially in technical schools.

KEBERKESANAN PENGGUNAAN GEOMETER'S SKETCHPAD (GSP) DALAM PENGAJARAN DAN PEMBELAJARAN MATEMATIK DI SEBUAH SEKOLAH TEKNIK, MALAYSIA

ABSTRAK

Kajian ini bertujuan untuk mengkaji keberkesanan sejenis program perisian geometri interaktif, Geometer's Sketchpad (GSP), dalam pengajaran dan pembelajaran matematik di kalangan pelajar sekolah menengah teknik. Kajian kuasi eksperimen ini telah dijalankan ke atas 56 orang pelajar dari sebuah sekolah teknik yang dipilih secara rawak. Pelajar-pelajar terlibat dibahagikan kepada kumpulan kawalan dan kumpulan eksperimen menggunakan pensampelan kluster rawak (berdasarkan kelas). Kumpulan kawalan menerima kaedah pengajaran konvensional manakala kumpulan eksperimen diajar berdasarkan modul GSP merangkumi tajuk "Trigonometric Functions" bagi tempoh 8 minggu. Tiga set ujian, iaitu ujian pra, ujian pasca dan ujian pengekalan telah dijalankan ke atas kedua-dua kumpulan pelajar masing-masing pada minggu 1, 8 dan 10. Selain daripada ujian, soal selidik dan protokol temubual digunakan dalam pengumpulan data empirikal. Keputusan ujian dan soal selidik telah dianalisis dengan menggunakan statistik deskriptif dan inferensi seperti min, sisihan piawai, dan ujian-t. Dapatan kajian menunjukkan bahawa terdapat peningkatan dalam skor min bagi kedua-dua kumpulan, dengan kumpulan eksperimen memperoleh skor yang lebih tinggi. Hasil ujian pengekalan menunjukkan bahawa keupayaan pengekalan pengetahuan yang diperoleh oleh kumpulan eksperimen adalah jauh lebih baik berbanding kumpulan kawalan. Oleh itu, kajian ini menyimpulkan bahawa penggunaan GSP sebagai alat dalam pengajaran dan pembelajaran matematik telah meningkatkan pencapaian dan keupayaan pengekalan pengetahuan pelajar. . Melalui kajian ini juga para pelajar dan guru telah menunjukkan sikap positif dan bersemangat tinggi terhadap pendekatan baru ini. Dapatan kajian juga menyokong teori-teori dan model yang digunakan dalam kerangka konseptual kajian ini. Implikasi daripada kajian ini adalah GSP boleh digunakan sebagai alat yang sangat berkesan untuk meningkatkan pengajaran dan pembelajaran matematik. Akhir sekali, kajian ini mencadangkan bahawa kementerian perlu merangka satu cara yang berkesan bagi menjamin komitmen guru menggunakan GSP dalam pengajaran matematik terutamanya di sekolah-sekolah teknik.

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ABBREVIATIONS

AE	Affective Engagement
AUC	Actual Usage of Computer
BE	Behavioural Engagement
DGS	Dynamic Geometric Software
FD	Field Dependent
FI	Field Independent
GSP	Geometer's Sketchpad
GC	Graphing Calculator
ICT	Information and Communication Technology
IT	Information Technology
MC	Mathematics Confidence
MCVE	Malaysian Certificate of Vocational Education
MMOE	Malaysia Ministry of Education
MSE	Mathematics, Science and English Language
MT	Attitude to Learning Mathematics with Technology
MTAS	Mathematics and Technology Attitudes Scale
NCTM	National Council of Teachers of Mathematics
NITTCB	National Industrial Training and Trade Certification Board
OFSTED	The Office for Standards in Education, Children's Services and Skills

PPSMI	Teaching and Learning of Science Mathematics in English
SES	Social Economic Status
SPM	Sijil Pelajaran Malaysia (Malaysia Certificate of Education)
TC	Confidence in Using Technology
UNITEN	Universiti Tenaga Nasional

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

This study seeks to investigate the effectiveness of dynamic geometrical software, namely Geometers' Sketchpad (GSP), in the teaching and learning of Mathematics in a technical school. The study explores the effect of GSP on students' achievements, the retention ability acquired by the students through the utilisation of GSP in the learning process and the attitude towards learning mathematics using GSP.

1.1.1 Technology in Education

Modernisation in society has moved rapidly thus making information and communication technology (ICT) essential in everyone's list. In education field, professionals from majority of the countries in the world realize that ICT could be one of the most important medium to improve the standard of education. The significant role of ICT to support improvement and transformation in education is gaining and increasing acknowledgement and comprehension by stakeholders in the sector. In addition, it is said that people are at a turning point in human history where the new net generation is in the process of reinventing civilization around a new set of principles and around a new communication medium (Tapscott, 2008). Tapscott later recognised the specific characteristics of the net generation that he called "the millennials" to be connected to the internet and has great affinity for digital technology.

In the new millenium, most teachers believe that technology is the answer to help individualized learning. Integration of technology in the classroom means a lot more than just using computers in classrooms. Rather in requires the innovative and meaningful usage of technology in a way that it facilitates the achievement of educational objectives. For barely a decade, the world has seen the revolution of the learning cultures as teachers' are more prepared to adopt technology into their teaching practices which has resulted in enhanced students' competencies (Dwyer, Ringstaff & Sandholtz, 1991). Furthermore, Dwyer et al. (1991) has observed that the balance between the direct instruction and inquiry-driven strategies as promoted by the use of educational technology is being gradually achieved by teachers.

A vast literature has shown that ICT could enhance teaching and learning. There are various benefits which ICT brings to Education, such as increased competency throughout the schools' various functionalities (Greene et al., 2002), enhancing two-way communication among teachers and students by numerous channels of digital communication. Cox (1997) remarked that learning through consistent use of ICT can influence the learning process positively. Through ICT, teachers could share and maximise available resources as well as transferring expertise and experience among them. According to Harrison et al., (1998), with ICT literacy skills, confidence and enthusiasm, teachers could have a greater flexibility in carrying out their lessons and tasks. In fact, according to Perry (2003) classroom planning and preparation especially in terms of material designs are getting easier by using ICT. Teachers could access the required data on students and school in real time by using ICT. Another point made by Perry was the use of ICT by teachers could enhance their professional image.

According to Becker (2000), students are more involved and positive when given assignments that includes the use of computers compared to other type of assignments. In addition, the use of computers in the teaching and learning process may encourage students to continue the learning process outside the normal school hours (Becker, 2000; Chen & Looi, 1999; Harris & Kington, 2002). From the teaching aspect, the quality of lessons could be tremendously improved through teachers collaborating to plan and organize teaching resources (OFSTED, 2002). Through better analysis of students' performance teachers can apply teaching approach that emphasizes on the

different level of students' abilities. This can help teachers to better understand the students and thus lead to more effective individual supervision.

Research also shows that the use of technology tools in the learning process is capable to increase students' self-confidence and motivation to learn. (Software and Information Industry Association, 2000). Pedretti and Mayer-Smith (1998) found that students in a technology-enhanced setting are more interested to learn than their counterparts in a conventional classroom. Greater opportunities for collaboration exercise with peers from the same as well as different schools are accorded to ICT-literate students (Chiu, 2002; Lipponen, 2000; Willinsky, 2000).

Recent research points to the fact that the usage of ICT can contribute significantly towards the positive achievement of schools. Schools furnished with good ICT equipment attained better results compared to schools with inferior ICT facilities. Similarly it was observed that effective usage of ICT in teaching a subject in a school produced better results than the other schools (Becta, 2003). Many research identify the strength and effectiveness of ICT in the area of literacy, numeracy and Science. Students who are ICT-proficient have shown improvement in writing skills (Moseley et al., 1999; Passey, 1999; Lewin et al., 2000). ICT could also enhance students' understanding of Mathematics concept through exploration and problem solving and in Science subject through the use of simulations (Becta, 2003).

Various methods can be used to acquire information and gain knowledge by means of ICT. Information is available through the internet or by using ICT-based

encyclopedia such as Microsoft Encarta. Students can also obtain information and knowledge through e-mail communications with students from other schools as well as students from different countries. A variety of standard ICT applications to perform calculations, writing or presenting ideas can be used. In addition, more specialized range of ICT tools for specific use are available in the market.

It is up to teachers to determine the extent of ICT integration in a lesson. In general teachers would experience some degrees of hiccups in their delivery process in the early phases. This is due to their getting use to and learning the technical know-how of the ICT tools. Students may also experience awkwardness in the transition from the traditional classroom to which they are accustomed to and the ICT integrated lesson. The use of ICT often creates opportunity for collaboration and teamwork among students. The interactions and changing of ideas in order to solve a given problem give a fresh learning experience which is valuable for the students when they enter the workforce.

Perhaps the actual concern is the difference between how students want to be taught and how most teachers carry out the teachings. The new generation of students prefers two way communications where they can ask questions and able to express their thoughts. They want to have a say in terms of what, when, where and how they acquire knowledge. They want their education to be stimulating and exciting. The relevancy of the education to the real world that they live in is of paramount importance to them. Thus, the education system and the teachers should respond reciprocally.

1.1.2 Integration of Technology in Teaching and Learning of Mathematics

Technology integration in the teaching and learning process of mathematics is not a new thing. Mathematics, as a discipline, does not escape from the influence of the rapid development of information and communications technology (ICT). In fact, mathematics educators are always looking for appropriate methods of integrating ICT in the teaching and learning of mathematics over the last decade (Ministry of Education, 2003). The use of ICT in mathematics education is an accepted approach and is embedded in the mathematics curriculum of many countries around the world. (NCTM, 2000; Garofalo et al, 2000). The integration of technology is now seen as a priority in the teaching and learning of mathematics in schools (Garofalo et al, 2000; Keypress, 2005). Technology utilisation in mathematics education is cited to be crucial (Ittigson & Zewe, 2003), in the way that it improves the teaching process as well as enhancing students' understanding of basic concepts. In addition the use of ICT in the learning of mathematics allows students to concentrate more on the concept and application of mathematics than the calculation (NCTM, 2000).

Many studies have been conducted to determine the benefits of using ICT in mathematics education. Becta (2003) has identified some of the key advantages of using ICT in mathematics namely the promotion of collaboration, communication and sharing of knowledge. Another advantage is the quick and precise feedback provided helps motivate students. The exploration features allow students to give more attention to the concept building rather than the tedious calculations (Ittigson & Zewe, 2003). This approach which is in tandem with the constructivist pedagogy promotes higher

order thinking skills and enhanced strategies for solving problem as recommended by the National Council of Teachers of Mathematics (NCTM).

National Research Council (2001) has suggested students can acquire more profound level of mathematics through the correct and optimum usage of technology. By allowing more time for modelling and conceptualising process of mathematics ideas, students get more interested and motivated to know deeper and thus, able to produce several solutions (NCTM, 2000). Many students are struggling to learn Mathematics today. Despite its significant impact to support progression in studies, many students are still being apprehensive towards the subject (Humphrey & Hourcade, 2010; De Wet, 2010). Niess (2005) has stated that technology offers a superior way of teaching Mathematics. It brings students to the same level regardless of their mathematics achievement (Campoy, 1992; Niess, 2005).

1.1.3 The Use of Geometer's Sketchpad (GSP)

Over the last decade, one important issue within the Mathematics Education circle is the effective use of computer-based technology in the delivery of the subject especially with the emergence of the Dynamic Geometry Software (DGS). It is said that DGS have become very powerful and effective tools in mathematics teachings. There are a lot of advantages offered by learning using dynamic geometry software. The effect of changing the shape of an object can be seen immediately and so is the effect of changing perimeter, area and volume of object in three dimensions. The changes are

demonstrated in real time, giving immediate response, while students are allowed to do calculations without being restricted to paper and pencils (NCTM, 2000).

Geometer's Sketchpad (GSP) which utilises exploration in Mathematics is a type of dynamic Mathematical software. The system can be used to create, explore and analyse various concepts in mathematics' fields such as algebra, geometry, trigonometry and calculus (Geometer's Sketchpad Reference Manual, 2001). Teachers and students can use and explore the interactive mathematical model constructed and animated using this software (Mahmud et al, 2009). The construction of dynamic image made possible by the functions in this software allows manipulation, analysis, conjecture and testing to be carried out.

According to Stacey (2007), in order to deepen the understanding of mathematical concepts, the use of exploration techniques features in GSP software should be embedded in the teaching and learning activities. GSP is expected to be able to enhance many aspects of Mathematics learning such as to strengthen the level of students' comprehension of mathematics problems, including when dealing with functions and variables, providing simulation as well as motivation to enhance the understanding of various mathematics fields such as Algebra.

Another mathematics field which GSP has an edge is the geometric exploration feature which enable students to manipulate the properties of geometric figures without having to delete or redraw them. While the alteration to the figures was made, calculation of angles, side length and ratio would be done automatically. This special

feature assists students to analyse and understand geometry better because they can discover the various possibilities that might arose as a result of changing certain magnitudes of the geometric figure. Furthermore, a lot of time is saved by not having to redraw the diagram every time alteration was being made. These sort of exploration activities obviously can enhance the cognitive competency (NCTM, 2000).

1.1.4 Malaysian Scenario

The use of computer technology in Malaysian schools for education purposes have grown remarkably. This, in part is due to the fact that Malaysia recognised the importance and the vast advantages offered by the integration of ICT and computer-based technology in the course of raising the standard of education. Moreover, the Malaysian Ministry of Education's (MMOE) vision to enhance the quality of delivery has led the ministry to make major investments in technology tools in the form of hardware, software and training. Following the 2003 announcement of PPSMI (the teaching and learning of science and mathematics in English) by the then Prime Minister of Malaysia, Tun Dr. Mahathir Mohammad, the MSE (Mathematics, Science and English language) teachers have received help and support from the Malaysian Education Ministry to help expedite the process of switching the medium of instruction by the teachers concerned. The assistance provided includes the ICT tools and teaching courseware as well as special training for the teachers.

In the case of Mathematics education, one particular dynamic Mathematical software that has been singled out for the purpose of teaching and learning of Mathematics was the Geometers' Sketchpad. The use of GSP in the process of teaching and learning of secondary schools Mathematics was clearly mentioned in the CS (Curriculum Specification) of Mathematics and Additional Mathematics subjects (Ministry of Education Malaysia, 2001). To further promote the use of GSP for the teaching of technical subjects, the GSP software were made available to all educational institutions nationwide through the purchase of GSP licence in 2004 (Ministry of Education, 2004).

Special budget had been allocated by the Malaysian Government in the area of teachers' training which includes Language Proficiency, Curriculum Contents, Pedagogy Course, and ICT Usage (Hishammudin, 2005; Sharifah, 2002) to boost the self-assurance and providing the essential expertise for MSE teachers to use ICT tools successfully in their classrooms. It is also anticipated that the investment would produce a technologically knowledgeable teachers who through the clever and meaningful usage of ICT tools and equipment in their disseminations of knowledge produces a capable and knowledgeable workforce to work in IT-intensive work environment. To this end, Ministry of Education has set an aim that all schools in Malaysia should reach a certain acceptable minimum level of computer usage in the course of teaching Mathematics, Science and English language subjects by the year 2008.

However, Chong, Sharaf & Jacob (2005) observed that these ICT facilities were not utilised to their full potential by the MSE teachers. The sending of teachers for ICT

courses designed to increase knowledge in the use of computer and ICT equipment did not translate into more integration of computer technology in the teaching. These teachers were found to revert back to the traditional teaching mode they were accustomed to once they returned from the training. A survey carried out in 2005 found that the average usage of ICT equipment by MSE teachers only account for 0.5% of the teaching hours which is measured as very low usage. (MHS Resources, 2005).

The purchase of the GSP licence is perceived to be beneficial for many teachers and secondary school students nationwide. However, the usage of GSP was not fully explored and capitalised on by many schools. Hence, its' strong features and advantages was not fully realised and put into effective use by teachers in their delivery of the subjects. As noted by Carlson and Gadio (2003), it is the technology acceptance by the teachers that will determine the successful implementation of technology in schools. Meanwhile, a study conducted locally by Teoh and Fong (2005) has shown that there was still issue to be addressed in the area of teachers' eagerness and inclination to use GSP in the teaching and learning process in Malaysian classrooms. According to a study carried out in many developed countries by the North Central Regional Educational Laboratory (2002), it was evident that the effective and innovative usage of technology in classrooms by teachers is influential in determining the students' success in the acquisition of knowledge and development of skills.

Education has become very competitive in Malaysia. This is true even in the secondary school level where high expectations have been put for students to perform in order to secure a place to progress to the next level of education. These high