The Intention to Use GeoGebra in the Teaching of Mathematics Among Malaysian Teachers

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ABSTRACT

This quantitative study examined Malaysian teachers' perception towards using GeoGebra in mathematics tea ching. The relationship between teachers' Perceived Current Competencies (PCC) of GeoGebra, and Intention to Use (IU) it as well as the difference between male and female teachers and between users and non-users of GeoGebra were investigated. An online survey was administered on 132 teachers who had already participated in GeoGebra workshops in Malaysia. The results of correlation and independent t-test revealed a positive relationship between teachers' perceived current competencies with their intention to use GeoGebra in teaching mathematics. There were no significant differences between male and female teachers in their intention to use GeoGebra in teaching mathematics. On the other hand, significant differences were observed between users and non-users of GeoGebra in their intention to use GeoGebra in their mathematics classrooms.

Keywords: *GeoGebra, mathematics, teaching of mathematics, educational technology*

INTRODUCTION

Teachers' attitude and behavior in the technology integration process has been emphasized by several researchers since teachers' beliefs and perceptions drive most of their teaching practice and make for better choices of student learning opportunity in the classroom (Cuban, Kirkpatrick, & Peck, 2001). Teacher contribution in this process is so significant that the National Council of Teachers of Mathematics (NCTM, 2000) declared teachers as one of the six main factors behind effective use of new technology in mathematics education. Therefore, to support teachers in dealing with the technology integration challenges, being aware of their beliefs and perception of new computer-based programs from different dimensions can ease this process.

GeoGebra, an open-source Dynamic Mathematics Software (DMS), is one of the recent instructional tools drawing much attention of researchers and mathematics educators for its potential to revolutionize mathematics teaching and learning. This program possesses the features of Dynamic Geometry Software, Computer Algebra System, and also spreadsheets all in a single integrated package (Hohenwarter, Jarvis, & Lavicza, 2009); it provides a virtual environment for students to simultaneously view both a numeric algebraic component (e.g., an equation or coordinate) and the geometric corresponding features of an object (Preiner, 2008). Discovering new patterns, exploring and testing conjectures, and manipulating various geometric shapes are among the numerous activities students can perform by designing and drawing their own sketches on dynamic mathematics software application (Stols & Kriek, 2011).

Previous studies indicate that GeoGebra improves the discovery learning process (Mainali & Key, 2012) and also students' motivation, engagement, and achievement in mathematics learning (Dogan & Içel, 2011). Several studies have reported positive attitudes of students and mathematics teachers toward using this software in mathematics teaching and learning (Saha, Ayub, & Tarmizi, 2010; Shadaan & Eu, 2013; Zakaria &

Lee, 2012). In a Malaysian qualitative study by Zakaria and Lee (2012) teachers found that GeoGebra is user friendly and employs straightforward and comprehensible instructions in addition to offering accurate and simple information. Şandır and Aztekin (2016) reported that pre-service teachers found GeoGebra easier to use than other dynamic mathematical software.

Despite the remarkable benefits of using GeoGebra in enhancing students' learning of mathematics and providing great opportunity for visualization, manipulation, and exploration of geometrical figures and mathematical concepts, a considerable number of teachers are still struggling with the task of effectively using it for everyday teaching (J. Hohenwarter, Hohenwarter, & Lavicza, 2010; Preiner, 2008). According to Žilinskienė (2015), "even though teachers have access to computers and appropriate software is available both in schools and at home, technology is rarely integrated substantially into everyday teaching" (p.139).

The results of a survey conducted on 151 secondary Math teachers in Malaysia revealed that only 2% of those who had attended the dynamic geometry software workshop used it as a classroom teaching tool (Osman, 2006). The teachers indicated lack of time, lack of technological skills, and lack of confidence as reasons for not using dynamic geometry software in their mathematics teaching (Meng, 2012; Osman, 2006). Several studies show that teachers' competencies from both technical and pedagogical points of view have significant impact on their intention to use technology. Agyei and Voogt (2011), found that among various barriers to incorporating new technology into teaching and learning as identified by mathematics teachers were the lack of knowledge about the ways to integrate ICT in lessons, and lack of training opportunities for ICT integration knowledge acquisition. Additionally, the study also mentioned that the current challenges of mathematics teachers include how to integrate new technology and how to design new learning activities for students. Žilinskienė and Demirbilek (2015) observed that Lithuanian primary school teachers' usage of Geogebra in the classroom depend upon intellectual property rights (IPR) in which they prefer free tools, as well as pedagogical impact in which the tool used must meet a learning objective. However, technological aspects of the tools were not much of a concern for the Lithuanian teachers due to their low ICT competency.

Purpose of the Study

As Malaysia is working at achieving better performance in international standardized testing such as Trends in International Mathematics and Science Studies (TIMSS) and Program for International Student Assessment (PISA), various angles are addressed, including integrating technology to improve Mathematics teaching. In Malaysia, using open source programs such as GeoGebra in mathematics education in schools is still new (Bakar, Ayub, Luan, & Tarmizi, 2010); there is also a dearth of research examining Malaysian teachers' perception of GeoGebra use in their mathematics teaching (Hutkemri & Nordin, 2011). Therefore, this study is focused on exploring Malaysian teachers' intention to use GeoGebra in the classroom teaching of mathematics based on their perceived current competencies. Perceived current competency in this study is an independent variable that anticipates the extent to which teachers feel that they have the actual proficiency, in terms of both technical skills and pedagogical knowledge, to utilize GeoGebra in classroom teaching of mathematics. It also determines their choice of further training and future professional development programs. Intention to use is a construct that defines a teacher's determination or plan to use GeoGebra as a teaching tool in the classroom.

Theoretical Framework

The Technology Acceptance Model (TAM) is one of the most popular and parsimonious frequently used model for assessing acceptance of new technology. TAM was proposed by Davis in 1989 (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989) and originated from the Theory of Reasoned Action (Ajzen & Fishbein, 1980) which claims that the intention to use a computer-based technology is influenced by its user's beliefs and perceptions. According to TAM, two main variables, perceived usefulness (PU) and perceived ease of use (PEU), are fundamental determinants of user acceptance. This model posits that the actual technology use is influenced by behavioral intention, and behavioral intention is in turn influenced by user's attitude toward the new technology system or program (Teo et al., 2008).

This study aimed at investigating mathematics teachers' intention to use GeoGebra in teaching mathematics as influenced by their perceived current competencies. As such, this research was implemented in accordance with a conceptual framework built upon the TAM by Davis (1989). In addition to the PU and PEU, this study intended to examine another perspective which is teachers' perceived current competencies (PCC) on their usage of GeoGebra as a teaching tool in the classroom. The gender differences between teachers in terms of GeoGebra usage were also examined on their PCC in using GeoGebra.

METHOD

This study employed the cross-sectional survey quantitative analysis method. The population of the study involved mathematics teachers who have been exposed to GeoGebra and its classroom applications through a workshop either organized by government departments such as Ministry of Education Malaysia under periodic teacher professional development programs, or non-governmental organizations such as the GeoGebra Institute of Malaysia. The GeoGebra Institute of Malaysia is a non-profit center that develops and supports the GeoGebra dynamic mathematics software application such as providing teaching materials and source codes, installers, web applications and services language files and associated documentation, as well as holding workshops. The total number of participants was 132, and they were mathematics teachers who have participated in GeoGebra workshops at some point during their teaching career.

Data were gathered via an online survey. The instrument used consisted of items on the participant demographic information, and items related to the constructs under study namely perceived current competencies (PCC) and intention to use (IU) GeoGebra. The PCC items were self-developed and validated by two academicians in the education field and two GeoGebra experts. The PCC item reliability was assessed through Cronbach alpha coefficient. A high value of Cronbach alpha (.93) was achieved. The items for IU were adapted from Davis (1989) and Pittalis and Christou (2011) and were validated in previous studies (Cronbach alpha coefficient was .75 for this construct). Responses were obtained using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

FINDINGS

A total of 132 survey responses were collected. In terms of gender distribution, 76 respondents were female while 56 were male. The respondents were also made up of 83 users and 49 non-users of GeoGebra.

The results of a bivariate correlation analysis displayed a statistically significant positive relationship between perceived current competencies (PCC) and intention to use (IU) GeoGebra among respondents (r = 0.507, p < .001). This positive correlation between two variables indicated that if teachers' perceived current competency increases, intention to use will also increase. The results are shown in Table 1.

Table 1 Correlation Between Perceived Current Competencies and Intention to Use GeoGebra

		Intention to Use (IU)	Perceived Current Competence (PCC)
Intention to use (IU)	Pearson Correlation Sig. (2-tailed)	1	.507** 0.000
Perceived current competence (PCC)	Pearson Correlation Sig. (2-tailed)	.507** 0.000	1

**. Correlation is significant at the 0.01 level (2-tailed).

An independent t-test analysis was conducted to examine whether gender differences play a role in perceived current competencies and intention to use GeoGebra among the teachers. The results in the following Table 2 revealed that gender differences did not have any influence on the teachers' perceived current competencies and intention to use GeoGebra in the teaching of mathematics.

Table 2 Results of Independent t-test on Female and Male Teachers' PCC and IU

Variable	*M*	*SD*	*t*	*df*	*p*-value
Perceived Current Competence (PCC)			-1.544	130	.125
Female	3.43	.733			
Male	3.66	.928			
Intention to Use (IU)			-.652	130	.515
Female	4.07	.756			
Male	4.16	.787			

Independent samples *t*-test analysis was again performed to evaluate the differences between teachers who were GeoGebra users and teachers who have never used the software in their perceived current competencies (PCC) and intention to use (IU) GeoGebra. The results indicated differences between the two groups in their intention to use GeoGebra for teaching and learning mathematics in which the scores of GeoGebra users were higher (M = 4.35, SD = 0.71), than that of non-users (M = 3.70, SD = 0.70), with t (130) = 5.09, $p < 0.05$. The statistically significant higher scores of GeoGebra users' IU suggested that being a user of GeoGebra had some influence on teachers' intention to use the software in teaching of mathematics. Similarly, statistically significant difference among the two groups was also observed for PCC with t (130) = 4.59, $p < 0.05$. Results are shown in Table 3.

Table 3 Results of PCC and IU Independent t-test on Users and Non-users of GeoGebra

Variable	*N*	*M*	*SD*	*t*	*df*	*p*	Cohen's *d*
Perceived current competence (PCC)				4.587	130	.000	
Users	83	3.77	.815				.85
Non-users	49	3.13	.684				
Intention to use (IU)				5.092	130	.000	
Users	83	4.35	.710				.92
Non-users	49	3.70	.692				

DISCUSSION

This study sets out to explore Malaysian mathematics teachers' intention to use GeoGebra in teaching mathematics in the classroom. The significant positive relationship between teachers' perceived current competencies and their intention to use GeoGebra found in this study indicated teachers who perceive themselves as skilful in the application will most likely use it in their mathematics teaching. This is supported by Jones (2001) who suggested teachers' readiness as a key factor in incorporating technology into classrooms, which is influenced by training, preparation, and work environments. Jones elaborates that learning new software, designing and developing suitable lesson plans to incorporate technology use, and transforming traditional instruction techniques are some of the challenges that teachers face when trying to embrace technology.

Lack of appropriate available training is often mentioned by teachers as a reason preventing them from taking full advantage of the great potential of educational technology and software. This is in line with Meng (2012) who suggests that, in Malaysia, there is an urgent need to develop secondary mathematics teachers' skills of using dynamic geometry software to provide helpful support and sustain the continuous integration of dynamic mathematics software into mathematics teaching and learning as advocated by the Malaysian Ministry of Education (Pittalis & Christou, 2011). Adding on to this perspective, the challenges teachers face when adopting technological means in the classroom need to address the "elimination of negative attitudes towards technology and demonstrate the changes that bring benefit, increase efficiency, and simplify work" (Radovic et al., 2014, p. 415).

To ensure that professional development needs in improving current classroom practices are fulfilled, Clark-Wilson and Hoyles (2016) suggest that the following elements be included in mathematics teachers' professional development programs:

- "Mathematical tasks that supported teachers to reflect on appropriate mathematical content and progression for each of the curriculum topics (developing both mathematical and pedagogical aspects of MKT).
- Short video clips and guidance materials that introduce and support teachers' instrumental geneses, which includes consideration of how teachers can, in turn support and develop students' instrumental geneses.
- Exemplar students' digital and paper/pencil productions embedded within professional tasks for teachers." (p. 7)

In short, should the teaching of mathematics require integration of software or other technological tools, teachers should be given enough exposure and training in using the technological tool as well as the pedagogical skills to ensure impactful delivery of classroom lessons. It is also imperative for schools to facilitate technology integration in the classroom by providing appropriate infrastructure, infostructure, and professional development support to ensure teachers' relevance in 21st century classrooms.

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