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WxMaxima Computer Software as an Aid to the Study of Calculus by Students with Different Learning Approaches

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Abstract

This study examined the effectiveness of teaching and learning calculus with the aid of the *WxMaxima* computer programme, as compared with the traditional method. In a quasi-experimental study, two classes of Malaysian secondary school Form Four students were randomly assigned to the control group (30 students) and the *WxMaxima* group (32 students). A Study Process Questionnaire (SPQ) was initially used to identify students with deep and surface approaches to learning. The findings indicated that students who were taught using the *WxMaxima* software performed significantly better than those in the traditional learning group. Further analysis showed that students with the deep learning approach in the experimental group achieved significantly higher post-test scores compared with students in the traditional learning group. However, there was no significant difference between the scores of the control and experimental groups who adopted the surface learning approach. This study implies that the use of *WxMaxima* could help students learn calculus more effectively, this being especially true among students who use the deep study approach.

Keywords : *WxMaxima*, Deep approach, Surface approach, Calculus, Computer Assisted *Instruction*

1. Introduction

The use of computers can be helpful in the teaching and learning of mathematics. The computer is viewed as a key component in the future of education because of its ability to help promote the development of learning and to create a more attractive and effective learning environment (Mohd Ayub, Mokhtar, Su Luan & Tarmizi, 2010). In Malaysia, the computer has been used primarily to support current methods of teaching, especially in the teaching of science and mathematics (Abu Bakar, Mohd Ayub, Su Luan &

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Ahmad Tarmizi, 2010). Mathematical softwares such as *Geometer's Sketchpad, Derive, Cabri, Matlab, Autograph* and others have been used widely in schools all over the world. However, their use in the classroom comes with a cost because these are commercial proprietary products.

Open source software offers school teachers the opportunity to integrate the use of computers into classroom teaching and learning. Softwares such as *SAGE, GeoGebra, WxMaxima* and others can be downloaded free of charge for use in the mathematics class. The use of such mathematical programmes has created a big impact on students' understanding in mathematics and in their subsequent performance in the subject. The softwares help students to visualize mathematical concepts and make their learning more meaningful. Tarmizi, Ayub, Abu Bakar, and Md.Yunus (2008) showed that students who learnt mathematics with computer technology integrated were more enthusiastic in their lessons and enjoyed them better than their counterparts who were taught using the traditional approach. Baharvand (2001) found that students using the Geometer Sketchpad software performed significantly better than students who learned mathematics conventionally. The students in the former group also showed a more positive attitude towards the subject. Tiwari (2007) who studied the use of mathematical software *Mathematica* in teaching and learning mathematics found that students introduced to the software achieved significantly higher test marks compared with those in the control group. In addition, the software also helped students to visualise abstract mathematical concepts. In an experimental study on the usefulness of the *GeoGebra* software, Abdul Saha, Mohd Ayub and Ahmad Tarmizi (2010) reported that students exposed to *GeoGebra* outperformed students in the traditional teaching-learning strategy group in coordinate geometry.

Identifying the learning approach of a student is important since it helps teachers choose the appropriate teaching methods for different students. Generally, students make a greater attempt to understand topics that capture their interest or if they see the relevance of what they have studied to their daily lives or future careers (Kember, Charlesworth, Davies, McKay, & Stott, 1997). According to the Biggs teaching-learning model (1993), a student's approach towards the learning process is a combination of his motivation and the strategy adopted during the learning process.

In this study, students' learning strategies are classified as either deep or surface approaches using the Study Process Questionnaire (SPQ) by Biggs, Kember and Young (2001). The deep approach refers to students' ability to relate new information to previously acquired knowledge. It also means that students search for relevant meanings as they relate what they have learnt to their daily lives and personal experiences. In other words, students using this approach are able to view learning materials from different aspects to obtain the entire picture. Other characteristics of students with deep approach strategies are their tendency to use meta cognitive skills, and develop learning materials that could form a basis for new ideas, offer other solutions from an inquisitive-critical perspective, and search and discover their 'inner self' (Beishuizen & Stoutjesdijk, 1999; Biggs, 1993). These students often become high achievers academically (Brown & Nelson, 1983; Bruch, Pearl, & Giordane, 1986). In contrast, students using the surface learning approach have a tendency to choose the quickest way to accomplish a task. Using this strategy, students acquire learning materials without asking in-depth questions, study the material in a linear manner, are able to relate to minimal aspects of the material or to a problem without showing interest, and learn by rote by relying on memory; they are concerned with the time needed to fulfil the learning task (Biggs, 1993). Students with this learning approach would focus on memorizing the main elements, using minimal meta-cognitive skills.

A study by Sii Ching Hii and Soon Fook Fong (2010) to investigate the effects of two modes of multimedia presentation among students with different learning approaches found positive effects of using multiple channel presentation (text + graphics, pictures + redundancy audio, video and animation) among deep and surface approaches learners. However, deep approach learners showed significantly higher achievement and motivational scores than surface approach learners. Another study by Van Melle and Tomalty (2000) on how computer technology (specifically the use of a multimedia CD-ROM) could