UNIVERSITI PUTRA MALAYSIA

EFFECT OF INTELLIGENCE TUTORING SYSTEM ON STUDENTS' ACHIEVEMENT IN ALGEBRAIC EXPRESSION

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EFFECT OF INTELLIGENCE TUTORING SYSTEM ON STUDENTS' ACHIEVEMENT IN ALGEBRAIC EXPRESSION

By

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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June 2007

Chairman: **Associate Professor Aida Suraya Md. Yunus , PhD**

Faculty: **Faculty of Educational Studies**

In this quasi experiment study, an Intelligent Tutoring System (ITS), was compared to the Computer Assisted Instruction (CAI) in tutoring students to learn the topic on Algebraic Expression. The ITS system consisted of two main structures in the architecture, the Student Model and Tutorial Model. The Student Model stores student's responses throughout the tutorial process while the Tutorial Model presents a suitable tutoring strategy to students according to their progress.

In order to identify the effect of ITS on student's achievement, 62 students in one of the private school in Perak were involved in the study. The Subjects consist of two intact groups. The groups were randomly assigned as the control group and the experimental group. One of the group studied algebraic expression in a CAI

learning environment, while the other were in a CAI and ITS (CAI+ITS) environment.

Before the experiment began, subjects were given a pre-test on algebraic expression, together with questionnaires of learning style and attitude towards mathematics. Post-test was given by the end of the study. The study was administered in eight slots with one hour per slot. Both groups of subjects studied the algebraic expression in CAI environment at first stage of the study. After completing the first stage, subjects from CAI group went through a tutoring session with CAI, whereas subjects from the CAI+ITS environment continue their study in ITS tutorial.

ANCOVA test was used to analyse the main hypothesis of the study. A Pre-test was set as a covariate and the gain score between the pre-test and post-test of study was measured. The result of the study showed that there was a significant difference in the students achievement in algebraic expression between students who learn with CAI+ITS and who learn with CAI only as delivery systems. However, there were no significant differences in student's achievement in algebraic expression among students with different learning styles or students with different attitude towards mathematics.

The findings of the study indicated that CAI+ITS was more effective in helping students learn algebraic expression as compared to using CAI alone. However, when a separate analysis was conducted for different delivery systems, neither CAI+ITS environment nor CAI only environment showed significant effects of any learning style or any category of attitude towards mathematics on student's achievement. This study suggests that educators and software developers should develop more ITS based learning tools or integrate ITS elements in courseware.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah master Sains

KESAN PENGGUNAN SISTEM TUTORAN CERDAS KE ATAS PENCAPAIAN PELAJAR DALAM UNGKAPAN ALGEBRA

Oleh

TSAI CHEN CHIEN

Jun 2007

Pengerusi: **Profesor Madya Aida Suraya Md. Yunus, PhD**

Fakulti: **Pengajian Pendidikan**

Dalam penyelidikan jenis eksperimen Quasi ini, penggunaan Sistem Tutoran Cerdas (ITS) telah dibandingkan dengan Pembelajaran Berbantukan Komputer yang tradisional (CAI) dalam membantu pelajar mempelajari topik ungkapan algebra. Sistem Tutoran Cerdas ini mengandungi dua struktur asas dalam reka bentuknya, iaitu Model Pelajar dan Model Tutoran. Model Pelajar menyimpan maklum balas pelajar dalam proses tutoran manakala Model Tutotoran akan memaklumkan strategi tutoran yang sesuai kepada pelajar berdasarkan perkembangan pelajar berkaitan.

Bagi mengenalpasti kesan ITS keatas pencapaian pelajar, 62 orang pelajar dari salah sebuah sekolah swasta di Perak telah terlibat dalam kajian ini. Subjek adalah

dalam dua kumpulan lengkap. Subjek dalam kajian ini telah dibahagikan kepada kumpulan kawalan and kumpulan eksperimen secara rawak. Salah satu daripada kumpulan berkaitan belajar ungkapan algebra dalam persekitaran CAI, manakala satu lagi kumpulan diberikan persekitaran CAI dan ITS(CAI+ITS).

Sebelum eksperimen itu dijalankan, pelajar diberi ujian pra berkaitan dengan ungkapan algebra, bersama dengan soal selidik tentang stail pembelajaran dan sikap terhadap matematik. Ujian post diberikan pada akhir sesi ekspeirmen. Penyelidikan ini dijalankan sebanyak lapan sesi dengan jangka masa satu jam per sesi. Pada tahap pertaman, kedua-dua kumpulan subjek belajar mengenai ungkapan algebra melalui CAI. Selepas melengkapi tahap pertama, subjek dalam kumpulan CAI meneruskan pembelajarannya melalui tutoran CAI. Manakala subjek daripada persekitaran CAI+ITS akan melengkapi sessi tutoran dengan tutoran ITS.

Ujian ANCOVA telah digunakan untuk menganalisis hasil dapatan penyelidikan. Ujian Pra ditetapkan sebagai asas perbandingan skor pencapaian pelajar dan perbezaan skor antara skor ujian pra dan ujian post diukur. Dapatan kajian menunjukkan terdapat perbezaan yang signifikan pada pencapaian pelajar dalam ungkapan algebra antara subjek yang belajar dengan CAI+ITS dan subjek yang belajar dalam CAI sahaja. Walau bagaimanapun, tidak terdapat perbezaan yang

signifikan dalam pencapaian pelajar berdasarkan stail pembelajaran atau sikap terhadap matematik antara pelajar dalam kajian ini.

Dapatan kajian menunjukkan kombinasi CAI dan ITS adalah lebih berkesan dalam membantu pelajar mempelajari ungkapan algebra berbanding dengan penggunaan CAI sahaja. Walau bagaimanapun, tidak terdapat sebarang kesan yang signifikan oleh mana-mana stail pembelajaran pelajar atau sikap pelajar terhadap matematik yang berlainan keatas pencapaian pelajar apabila menggunakan sistem penyampaian yang berlainan. Kajian ini mencadangkan agar para pendidik dan pembangun perisian menghasilkan lebih banyak bahan pembelajaran berdasarkan ITS atau mengintegrasikan elemen ITS dalam penghasilan koswer.

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I certify that an Examination Committee has met on 21st June 2007 to conduct the final examination of Tsai Chen Chien on her Master of Science thesis entitled "Effect of Intelligent Tutoring System on Students' Achievement in Algebraic Expressions" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the degree of Master of Science.

Members of the Examination Committee were as follows:

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This thesis submitted to Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date: 15th November 2007

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously of concurrently submitted for any other degree at UPM or other institutions.

Tsai Chen Chien

TSAI CHEN CHIEN

Date: 19th September 2007

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CHAPTER 1

INTRODUCTION

This chapter provides an overview of the background of the study, the statement of the problem, objective, research questions, hypotheses, significance of the study, operational definitions, and limitation of the study.

1.1 Background of the Study

Students often find themselves in a situation where progress is hindered because they lack fundamental algebraic skills. Many educators (Bowen, 1987; Heffernan, 2001) have expressed concern about student's lack of basic algebraic skills. They noticed students often make mistakes while executing algebraic operations. In addition, the importance of algebra has been addressed by the Chick, Stacey, Vincent and Vincent (2001). However, it is hard for educators to trace student's mistakes in algebraic. The mathematics teacher, therefore, should experiment with different methodologies in order to assure that he or she is providing the students with appropriate alternatives for learning (Fey, 1982).

As the world enters the new millennium, Information Communication Technology (ICT) is widely used in field of business, education, management and other field. Educators realized that computer is in great demand these days. To provide a more effective learning environment, Computer Assisted Instruction (CAI) had been developed. In recent years, CAI has expanded its influence into all subject areas (Piccoli, Gabriele, Ahmad, Rami, Ives & Blake, 2001). Numerous studies conducted by Alexender (1999), Jain and Getis (2003) and Leung (2003) to compare the effectiveness of CAI with the traditional method. These researches revealed statistical differences on student achievement and attitude between a CAI group and traditional group.

While CAI may be somewhat effective in helping learners, they do not provide the same kind of personalised attention that a student would receive from a human tutor (Ester, 1994). In order to achieve a more efficient learning environment, and to deliver the best learning process, research on ICT in mathematics education is focusing in the area of Artificial Intelligence (AI). Ester (1994) believes that AI is able to prepare a more human based interaction learning environment for students. Human based interaction learning environment is important in learning because it involves students in active learning.

Heffernan (2001) stated that as the techniques of AI becomes widely known and appreciated in the field of educational computing, AI with interests in education has also undergone changes in direction. He also stressed that the overall aim of developing AI is to enable the computer to be effective and act as a knowledgeable agent in the teaching and learning process. A major stand of research has been the design of the so-called Intelligent Tutoring Systems (ITS) which require knowledge representations to provide models of the subject domain, the leaner capabilities and the tutorial pedagogy (Heffernan, 2001).

According to Cumming and Abbott (1988), ITS such as PROLOG by Robert Kowalski have been under development for at least nearly twenty years ago. Other expert systems, like SNOOPY (Schauer & Staringer, 1988) have already been used in western schools since twenty years ago. SNOOPY is a simple system to demonstrate some of the methods and techniques used in Artificial Intelligence. It is essentially a dialogue program with simple natural language understanding capabilities.

The objective of an ITS is to provide a teaching process that adapts to the students' needs by exploring and understanding the student's special needs and interests (Kaplan & Rock, 1995). Research in the field of ITS has always had a strong focus on the development of comprehensive student models, based on the

assumption that within a problem solving context, learner's thinking processes can be modelled, traced, and corrected using computers (Julika,1999).

According to McArthur, Lewis, and Bishay (1994), ITS attempts to capture a method of teaching and learning exemplified by a one-to-one human tutoring interaction. One-to-one tutoring allows learning to be highly individualized and consistently yields better outcomes than other methods of teaching. Unlike previous CAI systems, ITS represent some of the knowledge and reasoning of good one-to-one human tutors, and consequently can coach in a much more detailed way than CAI systems.

Thus, in order to find out which of the learning environment, the ITS environment, or the CAI environment, is more suitable to help our students in their mastery learning of algebraic expression, this study attempts to investigate and compared the effectiveness of a CAI plus ITS (CAI+ITS) based approach and a CAI only approach in the learning of mathematics among secondary school students.

1.2 Statement of The Problem

According to Kiamanesh (1997), classroom instruction, attitude towards mathematics and learning styles are factors that affect mathematics achievement. In relation to this, previous studies have indicated that students always face difficulty in learning algebraic expression in mathematics (Booth, 1984, 1988; Greeno, 1982; Kieran, 1988, 1992; Lins, 1990). According to Chick et al. (2001), students who have difficulties in solving mathematics problem such as solving algebraic related mathematics problem, usually have problem keeping up with classroom instruction. In an effort to help students overcome these learning problems, some studies have discovered the potential of self-paced CAI as a delivery system.

Previous studies such as Bangertdrowns, Kulik, & Kulik (1985), Hughes (1974), Leung (2003), Teh, George, and Fraser (1995), Owens and Waxman (1994), Yalcinalp, Geban and Ozkan et. al. (1995) found that CAI have led to improvement in students achievement. Students in the CAI group were able to perform significantly better than students in the control group. However, recent studies such as Glickman and Dickson (2002), have indicated that Intelligent Tutoring System (ITS) as a delivery system have a greater potential than CAI to help students overcome difficulties in solving mathematics problems.