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Training Teachers to Use Computers for Instruction and Administration

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ABSTRACT

This paper presents the rationale behind the reconceptualization of a computer education programme for pre-service and in-service teachers in Singapore. It indicates the new directions for computer literacy in teacher education. The courses in the programme begin with using the computers as information processing tools and progressively incorporate knowledge and skills in using computer assisted learning packages across the curriculum and in programming. The results of the implementation of the courses are also discussed.

Phenomenal technological developments in the advanced countries in the world pose an immense challenge to the island republic of Singapore. Being their trading partner, Singapore has within the past few years embarked on a number of high-tech projects to keep pace with the "microchip revolution". Since the eighties, local private enterprises have produced some computer hardware and software and the government has established more effective communication and information systems in Singapore. This undoubtedly has serious implications for the education system.

Technological developments have also a ripple effect on people's expectations and the employment scene. Parents are nowadays expecting computer education for their children. Employers are making new demands on the new generation of workers. School teachers and principals are sensing the urgent need to be computer literate so that they can better prepare the children for their studies, future work and living in a high-tech society.

How is Singapore's education system and the Institute of Education responding to this urgent need and challenge? What is the state-of-the-art of computer education in the world and in Singapore? What are some of the major considerations in planning and implementing a computer education programme for teachers that attempts to meet the needs and challenges of the time?

State-of-the-Art of Computer Education

Recent trends in computer education have indicated major changes in the concept of computer literacy and a decreasing interest in programming at the lower level of computer learning. The concept of computer literacy has changed as societal values and technology have changed. The earlier concepts of operational literacy, instrumental literacy, and literacy as algorithmic reasoning while still in use have been found to be not entirely satisfactory (Culbertson, 1986). The latest proposition is literacy as education for altered roles. Noble has identified "consumer literacy", "worker literacy", and "citizen literacy" as the major relevant role-related concepts (Noble, 1984).

Operational literacy emphasizes knowledge about the basic components of hardware and software and machine-related skills to make

computers work and as such it has too narrow a focus. With rapid technological developments, teachers and students who are exposed to only one machine may have to relearn the operational skills every year.

The instrumental literacy approach uses the computer as an instrument for acquiring stipulated learning or bodies of subject matter. In Sweden, for example, teachers coordinated instruction in physics and mathematics using computers so that students gained new insights into mathematical relationships; some in social studies acquired new understanding of environmental problems through simulations and others in language arts used computers to enhance vocabulary and spelling skills (Megarry, et al, 1983). This approach confines computers to only teachers who are competent in programming or the use of application software to create computer teaching materials. The less competent programmers may have difficulty in teaching computer literacy.

Algorithmic reasoning, perhaps the most controversial concept of computer literacy, is acquired through computer programming. Mathematician John Kemeny believes in programming as a means to develop algorithmic thinking for solving problems or accomplishing a task (Kemeny, 1986). Seymour Papert stresses that programming helps to provide fundamental insights into mathematical and related abstractions (Papert, 1986). These and other like-minded computer scientists have their followers in many of the developed countries. To date, they still adhere to programming in BASIC or LOGO as an introduction to computers.

Other educators believe that computer literacy should be closely related to current technological and social developments. Noble, for example, advocates that role-related literacy should be more relevant for present day learning and teaching. Consumer literacy carries two meanings, one linked more to hardware and the other more to software. The first stresses that individuals should be effective acquirers and users of computers and associated hardware or peripherals. The second centres upon the "applications" individuals will be making "as part of their strategies for information retrieval, communication and problem solving". They will need to learn, for example, how to communicate through electronic mail, exchange ideas through computer networks, and use shared databases to solve problems. Schools, then, should provide students with the literacy skills required to function in the fast growing microelectronic environment. Teachers should therefore acquire computer literacy skills that are transferable to their students.

As a result of the changing view on computer literacy, from that of an operational to that of a consumer-oriented one, the focus of computer instruction in most parts of the world has changed. Alternatives to computer programming courses include the long-term objective of integrating computers into the curriculum, and the short term objective of developing a computer education curriculum based on applications software.

To integrate computers into the curriculum as a tool, computer application should be taught in conjunction with the subject areas. For example, word processing should be taught in writing as part of the English language and literature courses, spreadsheets could be used in mathematics, home economics, history, geography and physical education, databases of specific information could be used as instructional resource in social studies and science courses; and graphics packages could be introduced in art, mathematics or science. Simulation and games could be integrated into various content-appropriate classes — management, economics and decision-making situations.

Recent Studies on Computer Learning

Some studies on applications-based computer learning conducted in the United States indicated that they seemed to appeal to students more than programming courses. For example, in a study of 100 seventh-grade students enrolled in a computer literacy course featuring word processing and database managers, nearly two-thirds (63%) of the students agreed with the statement "I enjoyed working with computers" and more than half (56%) disagreed with the statement "computers are boring" (Lockheed, Gulovsen and Morse, 1985).

Voluntary enrolments in word processing classes are also balanced by sex. In the American High School and Beyond (HS & B) survey, for example, 51% of students enrolled in data processing and applications courses and 47% of students enrolled in computer literacy courses were girls (Rock et al, 1985). In the National Assessment of Educational Progress, NAEP data, 1985, for all types of computer use, no sex differences in course enrolments were found for students at any of the three grades of junior and senior high school assessed (Lockheed, 1985a).

In a study of learning English as a second language by multi-racial New York city students, Dalgish found that a database was very effective for discovering specific errors made. Armed with information about error types on a database, teachers and students could gain more control over discovering error types, accessing recurrent problems, and obtaining data to specify software development (Dalgish, 1987).

Computer Education in Singapore

Despite earlier attempts, computer education was only introduced fairly extensively to Singapore schools in 1980. It focused initially on teaching computer science as a subject at the pre-university level, computer appreciation courses at the secondary level and evaluation of the effectiveness of computer-assisted instruction in primary school mathematics. Most of the school computer appreciation programmes have, until 1986, concentrated mainly on programming in BASIC and LOGO.

According to a 1986 Singapore Ministry of Education report (Seah et al, 1986), every junior college has a computer club with membership varying from 60 — 100 students. At the secondary level, some 22,000 pupils (13.6%) are involved in computer club activities and 505 teachers are in charge of the clubs.

Facilities for computer learning have also been improved. All the 13 Junior Colleges now have two computer labs each. One of the labs is used for the learning of computer science, the other for the teachers and other pupils. By 1988, there are 21 secondary schools with their own computer labs each with at least 20 computers. Other secondary schools have at least three each and could apply for three more. This means that more schools will have their own computer labs and computer clubs and more students will benefit from easy availability and accessibility.

To teach the computer science course at pre-university level about 100 teachers were trained at the Nanyang University in 1980, while the Curriculum Development Institute of Singapore (CDIS) conducted courses for about 1,100 teachers in charge of computer clubs in secondary schools from 1980 to the present. Many of them continued as club advisers while others have relinquished their responsibilities in the computer clubs or have left the teaching service (Loh, 1987).

The Institute of Education(IE), Singapore also played its part in training some 500 teachers for the Computer Appreciation Clubs in primary schools from 1981 — 85. From 1986, IE has adopted a new teacher education programme for pre-service students. The Practicum Curriculum was introduced and computer education has become an integral part of teacher training. By 1987, all pre-service and in-service training at the Institute of Education had included a computer education course in the use of computer applications software, and computer-assisted instruction courseware. Computer education has also been extended to a wider range of in-service teachers. These include teachers training to be heads of departments or school principals. In 1987, a total of about 1,000 pre-service and in-service teachers were exposed to some form of computer education in the Institute of Education.

IE's Reconceptualised Computer Education Programme for Teachers

Rationale

In response to the challenges of the Information Age and the policies of the Ministry of Education and the developments in schools, the Institute of Education has reconceptualized its computer education programme. Accordingly, it has identified new objectives and strategies for its implementation.

Based on research and evaluation findings from the advanced countries and recent studies

by the World Bank, there is decreasing interest in BASIC programming and increasing emphasis on applications software skills. From various studies conducted in the past three years, courses featuring applications software seem to appeal to students more than programming courses do (Ramsden, 1984). There are fewer dropouts particularly among the girls after some exposure to applications-learning (Lockheed & Mandinah, 1986). Computer educators also argued for the parallel cognitive consequences of learning programming and applications software. Many of them also advocated appropriate learning theory-based software development (Vogeli, 1987).

Taking into consideration the past experience of the advanced countries like the United States, Great Britain and Australia, the IE computer education programme has been re-conceptualized to include the following key features:

(1) applications-based learning across the curriculum
(2) learning theory-based teaching and software development
(3) multi-systems approach for delivery and networking

Application-based Learning Across the Curriculum

The emphasis is on the use of applications software like wordprocessors, databases, spreadsheets, graphic and statistical packages to prepare teaching and learning materials in all subjects. For example, using wordprocessing to improve writing in English, or databases for storage and access of information and analysis of statistics in social studies, or a graphic package for mathematics.

Learning Theory-based Teaching

The importance of having a sound and reasonable theoretical basis for teaching and learning with the computer cannot be over-emphasized. Psychologists and educators have developed and tested a variety of learning theories that have provided a reasonably firm scientific basis for teaching and learning. However, most of the computer-based teaching is a poor imitation of classroom practice. For example, few mathematics and English Language courseware exhibit any awareness of principles of learning beyond Thorndikean stimulus-and-response.

Awareness and concern with the choice of software with a sound learning theory - base should be the hallmarks of well-informed teachers. The more interactive tutorial programmes are usually based on holistic learning principles and cognitive learning theories. This is specially true in the learning of languages. Students are required to answer questions, select choices or type information within the context of a complete discourse rather than give one-word responses to a simple phrase or sentence. In doing so, they improve in their understanding of a complete discourse and in their writing (Sinatra, 1987).

Multi-systems Approach for Delivery and Networking

The ability to use multi-computing systems is crucial in the Information Age. Teaching and learning with computers should not be confined to a single machine or a single system. Instead a multi-systems approach is adopted so that all trained teachers from IE will be comfortable using different software on different machines and different databases on different delivery and networking systems.

Based upon the above rationale, every computer education course conducted by the Institute of Education seeks to incorporate the three features mentioned regardless of student type and level of computing ability. This is to ensure the fulfilment of IE's computer education objectives.

Objectives

From the above rationale, three key objectives were derived for IE's Computer Education programme. Robert Taylor's (1980) method of organizing the three roles for the computer in education is used. These roles are tool, tutor and tutee.

Objective One: All beginning secondary and primary teachers and potential heads of departments and principals will be trained to use the computer as a **tool** for wordprocessing and creating spreadsheets and databases as they are related to a course of study.

Objective Two: Key subject teachers should have more knowledge about the computer as a

complementary means of instruction (as a **tutor**) across the curriculum. Computer assisted learning programmes will assume a tutoring function for abstract and difficult concepts. Key subject teachers should be able to pass on their skills to other teachers in schools.

Objective Three: Specially trained subject teachers should be trained to use the computers to improve pupils' reasoning skills through programming, or by creating computer-assisted learning programmes. In doing so, the students teach the computer (**tutee**) to create useful programme and learn something as well — a programming language and systems analysis.

Levels of Computer Education

To achieve the above objectives, IE's computer education programme has been conceived at three levels of training. These levels of training apply both to pre-service and in-service teacher education.

Level 1 — Basic knowledge of parts of a computer and its peripherals and their respective functions.
— Basic understanding of networking systems and knowledge of what is available and suitable for use in and outside the classroom.
— Computer as a **tool** for wordprocessing, data processing, record-keeping, graphic design for preparation of teaching materials, for assessment and administration.

Level 2 — Exposure to a variety of computer assisted learning (CAL) programmes that make use of the computer in the **tutor** mode in selected subject areas.
— Evaluation, selection, and utilization of CAL programmes for subject teaching.
— Using application software to integrate or create materials for subject teaching.

Level 3 — Learning computer languages, programming languages such as BASIC, LOGO, and C-LANGUAGE, and authoring languages like SUPERPILOT to a level of competence that will enable one to create CAL programmes in the subject areas i.e., the incorporation of the use of the computer as a **tutee**.

Current IE Computer Education Courses

With the adoption of the rationale mentioned, every computer course conducted by the Institute of Education has, as far as it is possible, incorporated the three features. This is to ensure that teachers are not only familiar with the use of computers, and the users and producers of this technology, but they are also able to educate pupils who reflect the same awareness and understanding of the symbiotic partnership of man and computer.

To ensure that the individual needs of the teachers are met, a three-level computer education programme with different kinds of courses has been proposed. The first level focuses on using the computer and computer software as a tool. In role-related terms, the user is a consumer, a worker or a citizen using computers to access, retrieve, communicate and store information. The second level looks at the tutor mode. The computer is used as an instrument to acquire knowledge and skills in specific subject areas or as a tutor to supplement teaching. Selection, evaluation and utilization of the available courseware are of great concern. The third level incorporates the tutee mode of the computer, that is programming and research related to computer education.

An example of the Level I course is the 30 hour pre-service Information Technology in Education (ITE) course for all Diploma in Education (Dip Ed) and Certificate in Education (Cert Ed) students. The student teachers are expected to acquire skills to operate and use the computer and a local area network for all subjects across the curriculum. They are expected also to learn to use applications software packages to do wordprocessing, create tables, graphs and charts, and databases for information storage. They also enjoy some hands-on experience in using the computer as a tutor when they try out and evaluate courseware in different subject areas on different machines, e.g. IBM JX, IBM PC, I.Apple 2E, Acorn-BBC computers. Though most of the programmes are of the tutorial types, students are asked to examine how they can be integrated

and used in their lessons in the subject areas of specialization.

Results from a study evaluating the computer knowledge of Dip Ed students after taking the course (1986/87) shows that all the 376 students passed the course after mastering the required skills in wordprocessing, spreadsheet, database management and LOGO graphics. In a post-course questionnaire, 75% of them agreed that wordprocessing was important to themselves. 81% of the Dip. Ed. students indicated that spreadsheets and databases were useful for their own personal management. Consistently, the math and science students indicated that computer applications were more important or useful to them than the arts and social science students (Koh & Harper, 1987). This disciplinary difference was more marked than gender difference as male students in the 1986/87 batch made up only 18.4% of the total population.

The Level 1 courses for potential heads of departments and principals have a different emphasis. In the Information Technology for Educational Management (ITEM) course, the participants are exposed to at least two important applications tools — a wordprocessor and a spreadsheet, and a range of computer-assisted learning packages across the curriculum. The participants of the Further Professional Diploma in Education (FPDE) and Further Professional Certificate in Education (FPCE) programmes, and the Diploma in Educational Administration (DEA) programmes for secondary and primary schools, are also exposed to the School Link project of the Ministry of Education. School Link is a computer network linking microcomputers in schools to a central computer system at headquarters. It has made available seven application systems for the schools. These include pupil management system, office system, question bank system, time-tabling system, financial system, library system and inventory system. Through the various components of the course, the participants learn not only to use the computer as tool and tutor but to manage computers and computer systems for administrative purposes.

At Level 2, the first such example is the Innovating An Educational Computing Project in School course for in-service teachers. It aims at exposing the participants to a range of applications software that can be used to create instructional materials in various curricula areas and computer-assisted learning programmes that have been developed on a firm pedagogical basis. These include individually and commercially produced programmes as well as locally created information and education databases such as the School and Home Interactive Network Exchange (SHINE) of the Singapore Press Holdings. The participants also created their own programmes by using software packages (e.g. a word-processor and a spreadsheet) and/or a language (BASIC or LOGO).

As a requirement of the course, the participants shared their knowledge and skills with the teaching faculty in schools by applying the most workable diffusion of innovation principles in conducting school-based workshops for their colleagues. Of the two participating schools in 1987, one-third of the entire teaching population learned word processing and more than half were exposed to a variety of computer-assisted instruction packages. One school was exposed to the SHINE database. In fact, the participating school principal himself designed two math programmes for SHINE. Other teachers in the school have also indicated an interest in designing programmes that explain difficult concepts with the assistance of SHINE.

Level 3 computer education courses are normally embedded within the subject teaching methodology courses. For example, Mathematics, Physics, Chemistry, Biology and Geography students are using the computer to programme instructional units as part of their Curricular Subject Option (CSO) courses. In these instances, the computer is used as a tutee. A number of programming and authoring languages are used. These include BASIC, LOGO, PROLOG, and SUPERPILOT. The student teachers are able to do so because they have learned these programming or authoring languages in the universities before joining the Institute of Education.

Future Directions

In view of the high-tech contexts of Singapore and her trading partners, schools and teachers

will not only be demonstrating their reliance upon computers and computer systems to improve the quality of administration and instruction, they will also have to prove their efficiency in employing high-tech resources and the growing number of information databases. There is also an expectation for the "computer experts" in schools to become the nurturers of computer talents and producers of pedagogically sound prototypic learning and teaching materials that can be shared among students of different learning ability.

The Institute of Education, being the one and only teacher education institution in Singapore, has to play an increasing leadership role in developing training programmes that will prepare teachers and school administrators for future high technology generations. The computer education plan described is only the beginning of a more comprehensive teacher education programme in the use of computers. There is provision for further development and expansion in line with the technological and social developments in the future.

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