PROLOG IN THE CLASSROOM :
THE SINGAPORE EXPERIENCE

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INTRODUCTION

This study will examine the effects of providing lower ability students in Singapore with computer-assisted instruction (CAI) (written with PROLOG-based software) relative to the traditional expository mode of instruction for a sample of geography classes in Singapore.

Several aspects differentiate this study from previous CAI effectiveness studies. First, previous studies used software that was written primarily in procedural languages such as BASIC, PASCAL, LOGO. On the other hand, the software that will be used in this study utilizes micro-PROLOG, the microcomputer version of PROLOG. PROLOG is a high-level fifth-generation declarative language developed for artificial intelligence research. PROLOG-based software is robust, compact and accessible to children [Dean, 1986].

Secondly, in addition to instruments that will be used to measure student academic achievement and attitudes, this study will also incorporate a measure to assess the psycho-social environment in PROLOG-based CAI classrooms [Anderson & Walberg, 1974; Fraser, Anderson & Walberg, 1982; Fraser, 1986a, b; Trickett & Moos, 1973; Moos & Trickett, 1974; Rentoul & Fraser, 1979; Fraser, 1985].

Thirdly, many previous studies used software programs that have their instructional components (e.g. subject matter and instructional strategy) stored and implemented in a single structure [Park & Seidel, 1987]. In this style of CAI, the student has little or no initiative in the instruction. In contrast, the software used in this study is underpinned by John Dewey's philosophy, "learning-by-doing", as the basic instructional approach in the system [Dewey, 1910; Sleeman & Brown, 1982]. In this approach, the student is required to engage actively in the instructional process to formulate and test his or her own ideas and to witness the consequences resulting from the system's reactions to his or her behaviours. This system takes a student-centred discovery form.

Finally, the present study will use software that is essentially Intelligent Knowledge-Based System (IKBS) shells. With these shells, students can input information which the programs then manipulate in a recognisably logical manner. In contrast, previous studies employed software programs which the students cannot debug, decode or alter, i.e. students could only run and execute the programs.

RESEARCH QUESTIONS

The following questions will be the focus of this study:

(1) Will lower ability students studying in Secondary Two who have been provided with the PROLOG-based CAI mode of instruction on the concept of decision-making in geography perform better than students who use the traditional materials prescribed by the Singapore Ministry of Education on measures of:

(a) knowledge of the experimental topics,

(b) attitudes to learning geography with computers,

(c) the psycho-social classroom environment;

(2) Will the CAI mode of instruction have different effects on the girls and boys in this sample in terms of these criterion measures?

REVIEW OF LITERATURE

The conceptual framework is based on literature reviews relative to CAI from four perspectives:

(1) The role of the computer in geography teaching;

(2) The problem of software quality, particularly in the area of geography teaching;

(3) PROLOG-based computer-assisted learning environments; and

(4) The problem of incomplete CAI research.

Although computers have been used increasingly to improve teaching and learning in geography, it is beset by many problems, and surrounded by many misconceptions [Shepherd, 1985]. Some of these have been elaborated by Chambers & Sprecher [1980], Shepherd, Cooper & Walker [1980] and Shepherd [1985]. Despite these difficulties, computers can make a real contribution to almost every type of teaching method and most content areas of geography at school and tertiary levels [Gibbs & Jenkins, 1984; Phillips, 1982; Fraser, 1981; Burkhardt, Fraser & Wells, 1982; Yates, 1980; Unwin, 1981; Walker, 1986].

Winship [1989] and Bigum et al. [1987] believe that one of the reasons for the problem of software quality is the lack of authors. Quality CAI software is too time-consuming to write, requiring mammoth investment of resources. The question to be asked is whether software based on an AI approach in general and on PROLOG in particular, would possibly present a solution to the authoring problem? In other words, might the use of PROLOG-based software present a substantial resource savings when it comes to putting together CAI-ware?

Although many studies have been conducted on CAI effectiveness [see, for example, Bangert-Drowns, 1985; Kulik, Kulik & Shwalb, 1986; Kulik & Kulik, 1987; Rosenberg, 1987], these studies have not concentrated on attitudes and classroom psycho-social climate, and thus have not looked at the complete picture. An important element is perhaps missing in the research literature.

Also, it has been difficult to assess the impact of CAI on achievement. Could this be, in part, because few if any studies have used criterion-referenced tests to measure outcomes?

And although some initial studies have been carried out to assess the effectiveness of PROLOG-based IKBS [e.g. Dean, 1986], a larger study involving more experimental subjects and schools would perhaps verify the extent of effectiveness of this type of CAI.

EXPERIMENTAL PROCEDURES

The sample for this study will comprise approximately 900 lower ability students from 20 intact Secondary Two classes in Singapore. These 20 classes will be from ten schools which will be randomly selected. Of the two similar classes in each school, one class will be randomly assigned as the treatment class and the other the control class. All schools will be co-educational in order to allow an unconfounded test of whether PROLOG-based CAI is differentially effective for boys and girls.

A comparison of general ability scores will reveal whether the treatment classes and control classes in all groups are fairly evenly matched in terms of general ability. The unit of analysis will be class groups rather than individual students and the analysis will be carried out on class mean scores.

The experimental design for this study will be the pretest-posttest control group design [Campbell & Stanley, 1963]:

Experimental (CAI)	... R 01 X 02
Control (traditional)	... R 03 04

where

X	denotes the treatment
R	denotes random assignment
01 and 03	denote the pretest
02 and 04	denote the posttest

The experiment will be carried out with ten groups comprising a treatment and a control class in each group. One treatment and one control class in each group will be taught by the same teacher (designated the research assistant), who also will be involved in administering the pretests and posttests.

The treatment materials for this study will consist of a set of materials on the concept of decision-making in geography used for sixteen 35-minute lessons, over a period of two months. This concept represents one of five concepts that made up the Secondary Two Geography Syllabus for Singapore. The teaching method for the experimental groups will be the PROLOG-based CAI mode of instruction. The teaching method for the control groups will be the traditional expository approach.

In order to maintain group equivalence , both the experimental and control groups will be:

(i) subjects who have used a computer before. Prior experience of the experimental group with a computer will also control any Hawthorne effect which may arise;

(ii) taught by means of the cooperative approach. Lessons will thus be generally student-centred. Students will also work on a small group basis.

A pilot study will be conducted to try out experimental procedures. The pilot testing will be carried out after the mid-year examinations in 1989 when normal lessons will not be conducted. The researcher will go through the procedure as for the treatment classes.

STATISTICAL PROCEDURES

Statistical procedures will be based on two phases: descriptive and inferential.

In the first phase, descriptive assessments of the differences between control and treatment groups will be generated. Histograms will be made for each dependent variable, for each group, and presented in a manner which enables inter-group comparisons to be made.

Three quantitative indexes of between-groups differences will be computed: the effect size estimator from meta-analysis; "eta-squared", the correlation ratio (formed by dividing the between-groups sum of squares by the total sum of squares); and "omega-squared", the estimate of the value of the correlation ratio in the population.

Since post-experimental results may be due to pre-experimental disparities in ability, pre-test and ability scores will be partialled out of the respective post-test scores, and the same graphs and statistics computed. Standard linear regression procedures will be used to partial out the scores.

If the results of the descriptive phases signal the presence of a meaningful treatment impact, such as a value of 0.3 for the meta-analysis estimator, analyses of covariance (ANCOVA) will be computed to test the hypothesis that observed between-group differences could be attributed solely to sampling error. The value of 0.3 is suggested as a usable cutoff point as it was the average effect found in Kulik & Kulik's 1987 review of CAI effectiveness.

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