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AUTHOR Baron, Lois; And Others
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ABSTRACT

A study was made of the effects of group size and time-on-task on the ability of 259 fifth- and sixth-grade students to learn in the context of computer assisted instruction. Predominantly Jewish, subjects attended one of three schools in an upper-middle-class area of Montreal. After the Basic Word Vocabulary Test and a background/demographic questionnaire were administered as pretests, subjects were randomly assigned to groups differing in size. In the fifth grade sample, there were 22 groups of 4 children, 23 groups of 2, and 22 groups of 1. In the sixth grade sample, there were 15 groups of 4 children, 13 groups of 2, and 12 groups of 1. Time-on-task was distributed across schools. One school received one half-hour treatment, a second received two half-hour treatments, and a third received three half-hour treatments. During the treatment phase, subjects were assigned computers and were told (1) to complete Level 1 of the "Word Attack" software program, and (2) to continue the program at whichever of the three remaining levels they chose. While students worked, experimenters gathered observational data. After completing experimental sessions, subjects were given three post-tests: two vocabulary tests, and one attribution questionnaire. Preliminary findings indicate that improved achievement resulted from increased time-on-task, but not from group size. (RH)

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A Preliminary Look at Group Size Effects and Learning on the Microcomputer: Implications for Early Childhood Education

paper presented at
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by

Dr. Lois Baron
Dr. Philip Abrami
and
Linda Wasserman
Concordia Univerity
Montreal, Quebec

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Introduction

Objectives:

The purpose of the proposed project was twofold: 1) to integrate two areas of inquiry in education--computer assisted instruction and the social psychology of education and 2) to investigate the ways computer-assisted instruction can be optimized given common practical restraints. The main purpose of this three-year study is to develop a model of computer aided learning which emphasizes the cognitive development of students while focussing on interpersonal skills and the affective domain. Practically speaking, the aim is to provide a guide for the implementation and use of computers in the classroom which recognizes the current and short-term future of computer implementation.

Realistically speaking, there most likely will not be a one-to-one correspondence between students and computers for years, if ever. Consequently, educators must be concerned about the optimal allocation of limited computer resources. In proposing this research, it was assumed that students and teachers have similar restricted access to computers regardless of school district, grade level, student ability, sex, ethnicity, subject matter, etc.

Research on classroom dynamics suggests that learning in groups can facilitate the cognitive, social, and affective development of primary and secondary school

children. What then, is the effect of students' using computers in groups? Are there unique properties to computer assisted instruction (e.g. individual pacing, immediate feedback, etc.) which moderate the effects of group learning? If so, what are these properties, and what are the prescriptions for modifying them?

Assuming that there is one personal computer per sixty students, what is the best way to allocate thirty minutes of computer time available during the normal school week to the students? Allow each student thirty minutes? Pairs 60 minutes? Triads 90 minutes? etc. The major concern of the work reported here has been to determine optimal group sizes which enhance individual student achievement and socialization considering the time-on-task variants which different group sizes permit. The research question addresses the dual concerns of effectiveness (e.g. how much does each student learn) and efficiency (e.g. what group size and contact time is best).

Computer Assisted Instruction:

Very briefly...what sort of findings are available in the literature on the effects of computer assisted instruction or C.A.I.?

Computer assisted instruction or CAI has been hailed by Magidson (1978) as an "educational promise to individualize

and personalize the instructional process and to simulate experiences not readily available."

Much has been learned about CAI within the last 20 years. Trends are beginning to surface in the research as to the effectiveness of CAI in the classroom. Studies have shown that CAI does have a positive, significant effect on student achievement, especially when used as supplementary material to regular classroom instruction (Kulik, Kulik, & Cohen 1980 and Kulik, Bangert, & Williams, 1983). Research has shown striking consistencies in results, even though the typle of CAI mode used (tutorials, drill and practice, games,simulations) and age of students have varied.

Overall, a review of literature has revealed the following consistencies in the result (Chambers and Sprecher, 1980):

"1. The use of CAI either improved learning or showed no differences when compared to the traditional classroom.

2. The use of CAI reduced learning time when compared to the regular classroom.

3.The use of CAI improved student attitudes toward the use of computers in the learning situation" (p.336).

Hativa (1984) refers to meta-analyses in the area of CAI. Work has revealed that CAI "has proven to be especially effective when it is used to supplement traditional teaching and when it is used in the subject

matter of mathematics. Gains in reading and in language arts are smaller and not statistically significant (p.293).

Results of studies point toward effectiveness of CAI at the secondary-school level. Would these findings also hold true at earlier stages of learning--a time when children are developing learning and thinking patterns?

Group Processes in the Classroom:

The meta-analysis conducted by Glass and Smith (1979) to explore the relationship between class size and student achievement and other outcomes (e.g. student and instructor attitudes) suggests a negative curvilinear relationship exists between class size and achievement as well as attitudes toward learning. That is, as group size increases both learning and attitudes toward learning decrease. Importantly, however, the effects of increasing group size were noticeable only with very small group sizes. When class sizes were modest, increasing the number of students had minimal effects.

Glass' meta-analysis supports our contention that group size is an important variable within our frame of reference. The results speak to the potential lower effectiveness of group learning compared to individual instruction, but do not address questions of efficiency. Research by Bloom (1976) and others on time-on-task has established a strong positive relationship between the amount of time students

are actively engaged in on-target learning activities and achievement. Thus, we might hypothesize that whereas group learning is somewhat less effective than individual instruction, it is more efficient. When computer time is limited, individual achievement can be optimized by (some ideal) student team learning.

The issue of group size and learning outcomes brings up the concept of classroom reward structures and cooperative versus competitive learning groups. Questions arising from this area will be the direction of future research as the characteristics of group learning are examined in more depth.

Computer Assisted Learning and Group Learning:

Questions in this area are the main focus of this study. When one thinks of CAI, images of an individual learner in front of a terminal or microcomputer screen come to mind. Individual learning and individualized instruction are, however, two very different concepts.

Must working on the microcomputer involve social isolation of a child? This has been a question posed by many in the field who are not only concerned with experimental effects, but are also concerned about the potential expense of having a one student per computer ratio in the classroom. If working in groups has been shown to lead to increased achievement, why not take advantage of children's interest

in microcomputers, and use the technology as a medium to promote such positive group learning experiences?

Descriptive reports have alluded to teachers' observations that the introduction of microcomputers in the classroom has generally increased social interaction among young children particularly on problem solving tasks where peer tutoring, asking for assistance, and discussion among students over possible solutions becomes the norm as they work in groups on a microcomputer terminal. Loop and Christensen (1980) report, however, that teachers often focus on the lack of enough hardware which restricts access to the limited number of computers teachers do have. In fact, they state that students had to be socially aggressive to secure a place for themselves.

The latter observations illustrate two important issues that both governments and researchers must consider. First, as Loop and Christensen report, there has been a rapid 'horizontal spread' of microcomputers in education while 'vertical growth' or investigations into how to use computers for learning has made little progress. Consideration of the social setting of a 'computer augmented learning environment' is precisely one of the 'vertical growth' issues. Investigating peer interactions and group learning in such environments will clarify the nature of the interactions, be they positive or negative. Second, when is that asymptotic level reached when positive group experience

(both cognitive and social) with the microcomputers becomes competitive scenes amongst students?

There have been a number of studies investigating the nature of the interaction between CAI and group dynamics/learning. These studies have, however, been limited to the secondary and college levels. There is not one reported empirical study in the literature which explores the question in the elementary environment--a place in a young person's life where social and intellectual skills are just developing, a time when the introduction of the microcomputer in the learning situation may either hinder or promote such development. Hawkins (1983); Sheingold, Kane, & Endrewait (1983); and Hawkins, Sheingold, Gearhart, & Berger (1982) report on either recorded observations or teacher's comments that more positive social interaction takes place when students work in groups with the microcomputer. In the lattter study, the researchers conclude that more collaborative work took place in interaction with the microcomputer than with other classroom tasks.

With the introduction of portable microcomputers into classrooms from preschool to university, the elementary level has become a rich source for investigating the interaction between the technology and the learner. The younger grades represent children who are developing their social skills. If microcomputers are present in these

classrooms, first, how might they promote or hinder social interacion, and second, what ratio of microcomputer to student best facilitates both learning and social development?

Hawkins (1983) and Krasnor & Mitterer (1983) both refer to the importance of social interaction in the child's cognitive development. Hawkins cites Vygotsky's position that cognition originates in social interaction while Krasnor refers to Piaget and Inhelder's work which takes a similar position. Krasnor and Mitterer emphasize the potential of group problem solving with the computer--not only in terms of achievement, but also as a means by which children can practice those skills that lead to improvement in communication ability.

Generally, the literature on CAI and groups has demonstrated that achievement and the development of social skills can complement each other successfully. Briefly, it has been shown in a number of studies (all at the high school or college level) that learning in groups does not hinder the supposed individualized learning effects of individual CAI. Paired learning and learning in triads and quads with the computer has shown to be as effective. These findings also have important resource implications.

Besides demonstrating through his own research on grade 10 students that paired CAI learning is as effective as individual CAI, Lebel (1982) reviewed other studies (Love

1969, Kauveit & Livingston 1969, Cartwright 1972, Okey & Majer, 1975) all finding no significant differences between individuals and groups on CAI learning tasks. Similar findings are revealed in the work of Hirata (1973), Broderick (1974), Sutter & Reid (1969), and Trowbridge & Durnin (1984). The latter conclude that "the use of computer-based learning materials should not be restricted to individuals alone. On the contrary, many benefits are to be gained by having pairs, and under certain circumstances groups of three, working together" (p12).

In a more recent study, Johnson, Johnson, and Stanne (1985) manipulated reward structure by assigning grade eight students to either a cooperative, competitive, or individualistic learning situation with the microcomputer. The individual condition consisted of students working in groups with the 'rewards' going to individual learners within these groups. The results favor computer-assisted cooperative instruction.

The results of the above and other studies appear to favour group CAI at least at the college and high school level. The types of tasks learned and the age of students may have varied, but generally groups performed as well, and sometimes better, on achievement test items. However, these findings only scratch the surface. There is still the effects of different types of CAI, different subject matter, and reward structure on the achievement of children of

varying abilities and ages, and groups of different sizes. If we wish to find the most effective match between the medium and the learner, these variables must be looked at. Generally what types of groups learn best in interaction with the computer, what kinds of tasks are better-suited to group learning, and what sort of environment best promotes such positve learning and social development?

Method

Subjects

Two hundred and forty-two grade five and six children participated in the study. The children were chosen from three schools within a five mile radius of each other in an upper middle class area of Montreal. Two of the schools were Jewish day schools while the third has a large Jewish population. Of the two hundred and fifty-nine subjects (Ss), 160 were grade five students.

Parent permission slips were requested before children could participate in the study. The Ss were treated in accordance with the "Ethical Principles of Psychologists" (American Psychological Association, 1981).

One hundred and sixteen of the Ss were girls, while 126 boys participated in the study.

Apparatus and Materials

The study was carried out in a room set aside for the purpose of the research in each of the respective schools.

The equipment consisted of Apple II's and either monochrome or coloured monitors. Equipment was provided by both the schools and the university research team.

The software (Computer Assisted Instruction) chosen for the study was Word Attack by Davidson and Associates, Inc., 1983. The program consists of a four-part vocabulary building element designed to teach students the meaning and usage of new words. Word Attack was chosen because of its excellent evaluations on both instructional design and educational merit. Another important consideration in choosing this particular program was that learning outcomes are easily and objectively measureable. A data disk which accompanies the program supplies grade equivalent lists of words that can be used with the program. Teachers can use these or other words when using Word Attack. According to the company, the grade equivalent words have been chosen from basal readers in the California area.

Pilot testing was done in order to choose appropriate words for the purpose of the research study. The criteria that no more than 40% of the children should correctly identify a word on a post-test was established. Words from levels seven (grade eleven), eight (grade twelve), and nine (first year university) which met this criteria were ultimately chosen, and entered into the program. Generally, words from levels below seven were found to be too easy for this sample of children. Pilot testing also led to only

nouns being entered on the data disk as the use of adverbs and verbs provided too many clues to the children.

Instrumentation

Pretesting subjects consisted of administering The Basic Word Vocabulary Test (BWVT) and a background questionnaire to all Ss. The BWVT (Jamestown Publishers, 1975) measures vocabulary development. The test resembles the vocabulary sections of most reading achievement tests and ability tests. It has a median correlation of .76 with test scores on the verbal sections of the Sequential Tests of Educational Progress (STEP) and the School and College Ability Tests (SCAT). The BWVT has an internal consistency reliablity of .96. Results on the test reveal both criterion and norm referenced data. The test is untimed. Subjects are asked to read a word or phrase and indicate its meaning by choosing the answer from a list of 5 alternatives. One stops scoring an individual protocol once 10 errors are made by the student.

The background questionnaire asked for general demographic information. Students were also asked questions related to their history of computer use and familiarity with Word Attack. A final question inquired about students' choice of 'play' friends in the class.

A twenty-five item post-test questionnaire was developed by the research team. The target, distractor words, and format were taken from the Word Attack program.

Procedure

The independent variables for this facet of the study were group size and time-on-task. Students were randomly assigned to different size groups. There were 22 groups of four, 23 groups of two, and 22 'groups of one' in the grade 5 sample, and 15 groups of four, 13 groups of two, and 12 'groups of one' in grade six.

Time-on-task was stratified across schools with one school receiving a one-half hour treatment (T1); the second school, two half hour treatments (T2); and the third school, three half hour treatments (T3). Students having to attend more than one session did so over a period of two or three weeks. There were 27 groups in T1, 19 in T2, and 23 in T3 at the grade 5 level.

The grade six sample was taken from the two Jewish day schools. Time-on-task was assigned to individual classes with one class (10 groups) receiving a one-half hour treatment; two classes (20 groups), 2 one-half hour treatments; and one class ,3 half-hour treatments.

Before the beginning of the treatment, the participants were administered the pretest instruments. On return to the classroom for the experimental sessions, the experimenters informed the Ss about the nature of the research. They were also told that they would be divided into pre-assigned groups. Students were given the choice of not participating. The Ss were taken one-half a class at a time

to the computer room where the computers were already booted with the Word Attack program. Once in the experimental room, Ss were assigned to computers in their groups and given instructions on how to proceed. They were introduced to the program and informed that it consisted of 4 levels. The Ss were told that they must complete level 1 first, and then go on to whatever level they chose. Instructions on how to 'escape', press for help, move the arrow keys, and 'shoot' were detailed for the students on a blackboard.

The participants worked on the Word Attack program while the experimenters gathered observational data. The groups were encouraged as much as possible to answer their own questions and solve their own problems. When this was not possible, they were given help.

Upon completion of the experimental sessions, each class was given three post-tests: two vocabulary tests (including the multiple choice test described above), and an attribution questionnaire. For the purpose of this report, comparisons between experimental treatments having to do with manipulations of group size and time-on-task will be discussed using as the dependent variable the score on the multiple choice test.

Results and Discussion

The results reported here are very preliminary. They consist of the data gathered on the grade 5 and 6 subjects

together. Caution is urged in generalizing from these results until further data analysis is done. However, there are some interesting preliminary findings which ought to be reported.

An analysis of covariance was performed using the adjusted raw scores on the B.W.V.T. as the covariate. The results demonstrate that time-on-task was the only significant variable ($F=9.77, p < .001$). Improved achievement resulted from increased time-on-task. The main effect of group size was not significant, nor was the interaction between group size and time-on-task. The covariate accounted for a lot of the variance ($F=179.11$; $p < .001$).

Keeping in mind that the results are preliminary in nature and that the research was performed on only one type of software, this study is a start in dymystifying the commercial myth of one computer per child. We have demonstrated through our research efforts that groups of four do just as well on a post-test of achievement as do individual children. Furthermore, we have established the fact that there appears to be an optimal learning time for this particular program. These results have some important educational implications that ought to be explored with a variety of software programs and types (e.g. tutorials, simulations, word processing programs). Our research team expects to proceed slowly in looking not only at other

software, but also at other factors such as reward structure, attitudes to learning on the microcomputer, and other individual and task differences.

This study was so specific to the learning task and the children we tested that only through further research will we be more confident in our predictions related to such factors as group size and time-on-task.

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