DOCUMENT RESUME

ED 275 629 SE 047 634

AUTHOR	Suydam, Marilyn N.
TITLE	An Overview of Research: Computers in Mathematics Education, K-12. ERIC/SMERC Mathematics Education Digest No. 1, 1986.
INSTITUTION	ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, Ohio.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
REPORT NO	400-86-0016
PUB DATE	86
NOTE	3p.
AVAILABLE FROM	SMEAC Information Reference Center, The Ohio State Univ., 1200 Chambers Rd., 3rd Floor, Columbus, OH 43212 ($1.00).
PUB TYPE	Information Analyses - ERIC Information Analysis Products (071)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Academic Achievement; *Computer Assisted Instruction; *Computer Literacy; Computer Managed Instruction; Educational Games; *Elementary School Mathematics; Elementary Secondary Education; *Mathematics Achievement; Mathematics Education; *Mathematics Instruction; Programing; *Secondary School Mathematics; Skill Development; Student Attitudes
IDENTIFIERS	*Mathematics Education Research

ABSTRACT

This digest briefly reviews some of the current findings from research on microcomputers which seem most pertinent to teachers in elementary and secondary schools. Summaries are presented of findings related to: (1) status surveys; (2) computer literacy and mathematics instruction; (3) effects of teaching computer programing; (4) tutorial computer assisted instruction and mathematics achievement; (5) computer assisted drill and practice; (6) effects on students of mathematical games played on microcomputers; (7) computer managed instruction; and (8) student attitudes. (ML)

ERIC Clearinghouse for Science, Mathematics, and Environmental Education

1200 Chambers Road, Third Floor
Columbus, Ohio 43212
(614) 422-6717

Mathematics Education Digest No. 1, 1986

AN OVERVIEW OF RESEARCH: COMPUTERS IN MATHEMATICS EDUCATION, K-12

Until three years ago, it was possible to state that little research had been published on microcomputer uses in mathematics education. That is definitely no longer the case! While most of the research is still in the form of doctoral dissertations, it has begun to overflow into journals. This digest briefly presents some of the findings from research on microcomputers which seem most pertinent to teachers in elementary and secondary schools.

We know from research with larger computers that they can be used effectively in mathematics instruction in each of their various applications. Thus we have some assurance, for instance, that:

- Instruction supplemented by properly designed computer-assisted instruction (CAI) is more effective than instruction without CAI.
- Both drill-and-practice and tutorial forms of CAI are effective in developing mathematical skills and fostering student achievement.
- Programming skills can be taught at the elementary school level, and extended (dramatically, for those students with time and interest) at the secondary school level.

In this overview the status of implementation will be considered first, before considering findings on computer literacy as they relate to mathematics instruction, programming and its effectiveness, tutorial CAI, drill-and-practice programs, games, computer-managed instruction, and, finally, attitudes toward computers in the mathematics classroom.

Status Surveys

Mathematics has been the predominant subject area in which microcomputers are used, although word-processing applications are rapidly overtaking mathematical uses. The amount of commercial software for mathematics instruction is rapidly growing; for the past five or six years, this software was primarily for arithmetic, with the emphasis on drill-and-practice programs. Within the last year or two, however, more and more of the software is planned to supplement and extend topics in the curriculum rather than merely provide drill and practice. In particular, the amount of software on problem solving is increasing, as the focusing of the curriculum on problem solving advocated by the National Council of Teachers of Mathematics and other educational groups, combined with less-than-pleasing data from state, national, and international assessments, underlines the need to improve problem-solving skills. Frankly, much of the available software is not sensational from either an interest or an educational viewpoint, but both factors are improving.

> For a useful means of evaluating software, see Heck et al. (1984). Teachers should also check on software evaluations available from some state or regional educational agencies such as the Northwest Regional Laboratory MicroSIFT Program (Holznagel & Weaver 1982-86). See also Nye and West (1986). More than 100 pieces of software for mathematics and science were reviewed by elementary teachers from five school systems in Tennessee. Besides summarizing the intended use of each piece of software, learning activities which serve to integrate the software into the mathematics curriculum are provided.

By 1985, a majority of elementary schools had five or more computers, while half of the secondary schools had 15 or more, according to a survey by Becker (1985b). Only 7 percent of secondary schools and 15 percent of elementary schools lack computers. These data show a clear change from Becker's previous survey conducted in 1983 (Becker, 1985a). One point of interest is that elementary schools in 1985 appeared to be at the approximate point in attaining computers where secondary schools had been in 1983.

Computer Literacy

Computer literacy has been the focus of a number of studies. While many studies were concerned with computer literacy in general, some were connected with mathematics instruction:

- Use of microcomputer-assisted drill and practice on computation significantly improved both the attitudes toward computers and knowledge about computers.
- Even a five-week summer session on mathematics and computers was long enough to improve computer literacy.
- Boys and girls learn about computers equally well, but some attitudes differ. For instance, boys tend to consider computers and computing as a male domain more than girls do.
- Many students cannot be considered computer literate. For example, one-third of the 13-year-olds and one-fifth of the 17-year-olds questioned in the third national mathematics assessment believed that computers have minds of their own. Many did not realize that computers require special languages or that they are suited for doing repetitive, monotonous tasks (Carpenter et al., 1983).

Programming

Studies on the effects of teaching computer programming are varied in their findings:

- Some studies have found no evidence that students taught computer programming (most often with BASIC) have higher mathematics achievement than those not taught to program.
- In other studies, achievement was higher for those taught to program.
- Generally, no sex differences were found; when they were, boys scored better than girls on tests of programming skill.
- The same procedures were used by secondary school students in computer programming and in problem solving: heuristics, subgoals, looking back techniques, trial and error, and regular patterns of analysis and synthesis (Wells, 1981). In fact, such procedures were used even more frequently in programming than in problem solving, where they are stressed in mathematics instruction.
- Instruction in computer programming in either BASIC or Logo appeared to have a significant effect on the ability to analyze problems.
- While some studies reported no significant differences between students given or not given instruction with Logo, others reported success with using Logo to teach geometric concepts, problem solving, and spatial skills.

Tutorial Computer-Assisted Instruction

A large number of studies have involved tutorial CAI. As would be expected, the findings are mixed concerning mathematics achievement.

- Use of CAI produced higher achievement than did conventional instruction in many cases (as well as some affective benefits).
- In at least one case, achievement was significantly related to the amount of time spent on the computer.
- No significant differences between CAI and conventional instruction were found in a smaller number of studies.
- Significant differences favored the non-computer groups in only one study.
- CAI costs more than conventional instruction, but is lower when cost-effectiveness (based on achievement) is considered. Ash (1986) found that the cost-effectiveness index for computation was 2.840 for traditional instruction, more than three times larger than that for CAI (.819). For concepts, the index was 1.086 for traditional instruction and 1.273 for CAI. From a study in Canadian schools, Hawley (1986) reported that the cost of CAI was 24¢ per day per student *more* than the cost of traditional instruction in grade 3, and 30¢ more in grade 5. When based on cost per unit of gain in achievement, or on the value placed on mathematics attainment and computer literacy by school boards and parents, CAI can be considered more cost effective than traditional instruction, according to Hawley.
- Use of the computer as a medium for diagnosis was explored, with indication that it may be more effective than the teacher in this role.

Drill and Practice

Most of the studies on computer-assisted drill and practice focused on the elementary level where such software is widely used. Of 12 studies, eight reported that no significant differences in achievement were found between groups having or not having computer-assisted drill and practice. In only four of the 12 studies was achievement higher when computer-assisted drill and practice was used. This trend has been apparent in research with computers for over 20 years: drill and practice can be effectively administered by computers, but not necessarily more effectively than the teacher can provide non-computer drill and practice.

Games

The effects of various mathematical games played on microcomputers has been of interest to several researchers.

- Games were reinforcing and motivating. Using games as rewards, setting time limits, and playing with a peer were found to serve as extrinsic reinforcers.
- The computer game group responded correctly to twice as many items on a speed test of addition basic facts as did a non-game-playing group.
- While college students viewed games as problem-solving activities and applied a wide variety of problem-solving strategies, only about half of a group of eighth graders did so. They made limited use of such strategies as searching for patterns, while those not viewing the games as problems used random trial and error almost exclusively (Kraus, 1980).
- The importance and roles of challenge, fantasy, and curiosity in games differed for elementary school boys and girls.

Computer-Managed Instruction

Few studies of CMI have explicitly considered mathematics instruction. No significant differences in student achievement characterize each of three such studies. Teachers, however, preferred microcomputer-managed systems to non-computer systems — for obvious reasons.

Attitudes

Most students — but not all — like to work with computers.

- Fifth-grade students who used microcomputers for mathematics drill and practice and some programming daily for a semester were strongly positive toward microcomputer use. The children believed that microcomputers will improve education, that all students should learn about them, and that both boys and girls, at all ability levels, are equally interested in them (Kahn, 1985).
- Positive correlations between attitudes toward computers and attitudes toward mathematics have been found.
- Prior computer experience may have a greater impact on attitude toward computers than do other factors. If an experience with computers has been interesting, students want to do more with them.
- No significant sex differences have been found in attitudes toward computers.

Concluding Comment

As more research involving the use of computers in mathematics classrooms is published, we can expect to have more detailed information and specific suggestions on how to use them most effectively. We know they are a useful tool for mathematics instruction: now we must integrate that tool into the on-going curriculum.

Many suggestions on how to use computers effectively in mathematics instruction come from teachers' and students' experience. Journals such as the *Mathematics Teacher, Arithmetic Teacher, School Science and Mathematics,* and *The Computing Teacher* provide ideas you can use.

SELECTED REFERENCES

Ash, Ruth C. "An Analysis of the Cost-Effectiveness of a Computer-Assisted Instructional Program." *Dissertation Abstracts International* 46A: 2137; February, 1986.

Becker, Henry Jay. *How Schools Use Microcomputers: Summary of the 1983 National Survey.* Baltimore, MD: Johns Hopkins University, March, 1985a.

Becker, Henry Jay. *The Second National Survey of Instructional Uses of School Computers: A Preliminary Report.* Baltimore, MD: Johns Hopkins University, August, 1985b.

Carpenter, Thomas P., Mary M. Lindquist, Westina Matthews, and Edward A. Silver. "Results of the Third NAEP Mathematics Assessment: Secondary School." *Mathematics Teacher* 76: 652-659; December, 1983.

Hawley, David E. "The Costs, Effects, and Utility of Microcomputer Assisted Instruction in a Rural School Division in Canada." *Dissertation Abstracts International* 46A: 3206; May, 1986.

Heck, William P., Jerry Johnson, Robert J. Kansky, and Dick Dennis. *Guidelines for Evaluating Computerized Instructional Materials.* Reston, VA: National Council of Teachers of Mathematics, 1984.

Holznagel, D. C. and D. W. Weaver, eds. MicroSIFT *Courseware Evaluations, Sets 1-16.* Portland, OR; Northwest Regional Educational Laboratory, 1982-86. ERIC Document Reproduction Nos. 226 765 (sets 1-5), ED 234 772 (sets 6-8), ED 239 606 (set 9), ED 245 666 (set 10), ED 249 918 (sets 11-12), ED 260 710 (sets 13-14), ED 263 913 (sets 15-16)

Kahn, Laurel S. "An Exploration of Fifth Grade Students' Attitudes Toward Microcomputer Use." *Dissertation Abstracts International* 46A: 600; September, 1985.

Kraus, William H. "An Exploratory Study of the Use of Problem Solving Heuristics in the Playing of Games Involving Mathematics." *Dissertation Abstracts International* 41A: 1992; November, 1980.

Nye, Barbara A. and Barbara A. West. *Spinoffs: Mathematics and Science Computer Learning Experiences.* Nashville, TN: Tennessee State University, 1986. ERIC Document No. SE 047 470.

Suydam, Marilyn N. "Review of Research: Computers in Mathematics Education, K-12." Prepared for "Computers in Mathematics Classrooms" Conferences conducted by the National Council of Teachers of Mathematics, with funding from the National Science Foundation, in 1986.

Wells, Gail W. "The Relationships Between the Processes Involved in Problem Solving and the Processes Involved in Computer Programming." *Dissertation Abstracts International* 42A: 2009-2010; November, 1981.

Prepared by Marilyn N. Suydam
Associate Director, Mathematics Education

OERI
Office of Educational Research and Improvement
U.S. Department of Education

This digest was prepared pursuant to a contract with the Office of Educational Research and Improvement, U.S. Department of Education. Contractors undertaking such projects under government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions, however, do not necessarily represent the official views or opinions of the Office of Educational Research and Improvement.