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ABSTRACT

This paper presents alternative ways microcomputers can be utilized in the educational process. These uses are: (1) learning from, with, and about computers; (2) learning about thinking with computers; and (3) managing learning with computers. Each of these uses is discussed as to its applicability to current educational practice and possibilities for the future. The role of the teacher in each of these areas is discussed and the relative importance of computer hardware and software for each area is described. Specific recommendations for educator action, as schools begin to use computers, are: (1) development of school district guidelines considering roles for which computer systems can be used, quality of educational software, choice of hardware, maintenance budgets, and extent of teacher inservice necessary; and (2) increase of teacher knowledge of uses of computers through self-study, school workshops, and courses and/or degrees from institutions of higher education. Also included is a bibliography of books, journals, and articles. (JD)

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Computers in the Schools:

Methods of Utilization and Action Recommendations

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DRAFT

Abstract

This paper presents alternative ways microcomputers can be utilized in the educational process. These uses are; learning from computers, learning with computers, learning about computers, learning about thinking with computers, and managing learning with computers. Each of these uses is discussed as to their applicability to current educational practice and possiblities for the future. The role of the teacher in each of these areas is discussed and the relative importance of computer hardware and software for each area is described. Specfic recommendations for educator action are listed as well as a bibliography of books, journals, and articles.

Glossary

Author languages: Computer languages that allow users to program without having much knowledge of computer languages.

Bit: Acronym for binary digit. A bit, which is either 0 or 1, is the smallest unit of digital information.

Bug: An error in a computer program.

Byte: A byte represents the number of bits required to store one character of text. Most current microcomputers use 8 bits per byte, although newer models may use 16 bits per byte.

Cathode ray tube (CRT): The most common display device for microcomputers. Either a standard TV or a monitor which is a modified TV.

Central processing unit (CPU): The logic ("brains") of a computer. It executes and interprets the commands from the user.

Chip: A small flat piece of silicon on which electronic circuits are inscribed.

Computer: An electronic device that manipulates symbolic information based upon instructions.

Computer System: The various components of a computer and peripheral devices that allow for communication and storage of information.

Floppy Disk Drive: a peripheral device for storing information. It utilizes a flexible plastic disk that has a magnetic recording surface.

Hardware: The physical devices that make up a computer system.

High level languages: Languages that use English like commands to prepare programs for a computer. Examples are FORTRAN, BASIC, COBAL, Logo, APL.

Kilobyte (K): The number of bytes repesented by two raised to the 10th power (2^10). This is exactly 1024, but is usually rounded to 1000. For example, a 48K RAM machine would have approximately 48,000 bytes of RAM memory.

Microcomputer: A computer whose central processing unit is a microprocessor.

Microprocessor: A single integrated circuit that acts as the central processing unit.

Network: A communications connection between various peripheral devices or computers.

Random access memory (RAM): The memory in a computer that can be manipulated by the user through the central processor unit. The contents of this memory is lost when the machine is turned off.

Read only memory (ROM): Memory within the computer that has been fixed at the time of manufacture. This information can be read by the central processing unit but no new information can be written to it. Its contents do not disappear when the machine is turned off.

Software: The list of commands that tell the computer what functions to perform. These commands can be in various languages and do various tasks.

Wordprocessing: The utilization of a computer (many times a microcomputer) to create, edit, store, and have printed textual materials.

Introduction

The computer, and especially the microcomputer, has moved into practically every aspect of modern life. Banking, publishing, engineering, business, law, and medicine, have all seen their disciplines altered by the availability of relatively inexpensive microprocessors. Innovation in education has come at a somewhat slower pace probably due to a variety of factors. Among these are funding problems, the overall undistinguished results of uses of large computers in education, and the built in resistance to change. The microcomputer is, however, becoming more prevalent in schools and is expected to become more available in the near future. Market Data Retrieval Inc.(1) has reported a 61.2% increase in the number of schools with microcomputers in just the October 1981 to October 1982 time period. The same report also notes that the gap between larger school districts and smaller ones in obtaining microcomputers is lessening, with smaller districts (under 1200 enrollment) having the fastest growth rate in microcomputer purchase.

This growth, and the demands that it may place on school, leads to three questions of import for educators.

1. What are some of the models being followed in the utilization of microcomputers currently?

2. What demands will the increased use of microcomputers place on teachers and teacher training?

3. What are some steps that educators may take

to assist in developing use of computers in their educational situation?

Models of Computer Use

The book The Computer in the School: Tutor, Tool, Tutee (2), indicates that there are three main uses for the computer in the schools: the computer as a "tutor" (i.e., as a machine that teaches); the computer as a "tool" (i.e., as machine that can do things for you); and the computer as a "tutee" (i.e., as a machine that can be taught). Art Luehrmann, of Computer Literacy, Inc., has expressed these uses in a slightly different way: learning from the computer; learning with the computer; and learning about the computer. This model can be extended to five uses of the computer in the educational process. Each will be discussed in more detail within a separate section, but for an overview the five roles are:

1. Learning FROM computers.
2. Learning WITH computers.
3. Learning ABOUT computers.
4. Learning ABOUT THINKING with computers.
5. MANAGING learning with computers.

It is especially important to notice that the word "learning" is used in each of these uses. This learning can take place in schools, but can also take place in a variety of other environments such as the home or the workplace.

In order for these five types of computer based learning to take place in the school setting, various components must be brought together. The two major segments of actual computer systems are: the hardware, the physical components of the computer; and the software, the programs that are utilized with the computer hardware. These two pieces must be complemented by a third component, teacher training. Effective learning will probably not take place without all of the components, however, the three components do not necessarily have to be equally stressed. Some of the computer based learning situations may require a heavier reliance on one or two of the components and therefore a smaller demand for the remaining facet.

Learning From Computers

The two categories of instructional techniques that fall within this use in learning are drill and practice and tutorial. In drill and practice, it is assumed that the student has already been taught the appropriate material and the computer simply provides a large number of practice problems on this material for the student to work on. In tutorial, it is not assumed that student has already been taught the appropriate material. Instead, the computer takes the role of the dispenser of information and may include practice questions on the material as the tutorial lesson proceeds.

The utilization of drill and practice programs can be extremely useful in situations where students need extra practice to develop a particular skill, but the teacher does not have the time to work with each student individually. In addition, the motivational effect of using these programs can be quite strong, especially at first, because it gives the student the opportunity to do something different from the traditional workbook approach.

While drill and practice programs can be useful and effective in certain situations, their effectiveness is dependent upon the variety of responses and degree of interaction with the user that is built into the the program. For example, consider a program in which problems are generated to give practice in the addition of two one-digit numbers. In many programs of this type the only responses given are "correct, good job" when the given answer is correct and "no, try again" when the given answer is incorrect. No attempt is made in the program to vary the responses, or to make use of student's incorrect responses to diagnose what the student's difficulty in solving the problem was, or to provide a second chance on the same problem with an appropriate hint. The utilization of student responses is a critical component of good drill and practice programs. A poorly designed program that merely gives the response "wrong, try again" when the student makes an error is not really utilizing the power of the computer and is merely turning it into an "electronic workbook".

The second type of instructional technique that falls within this role of the computer is tutorial. This use of the computer as an individual tutor had been envisioned as early as 1966 by one of the pioneers in the educational use of computers, Patrick Suppes (3).

"One can predict that in a few more years, millions of school children will have access to what Philip of Macedon's son Alexander enjoyed as a royal prerogative; the personal services of a tutor as well informed and responsive as Aristotle."

Clearly, this has not come to pass "in a few more years" since 1966. The missing ingredient in this forecast was the importance that needed to be be placed on the skill and knowledge of the tutor in addition to the use of the one-to-one tutorial technique. The one-to-one tutorial approach has certainly been used over the centuries on people other than Alexander, but few of these uses have had the availability of a tutor as skilled in teaching and as knowledgeable about subject matter as Aristotle. The same situation has applied, and continues to apply, to the use of computers in tutorial instruction. A very small percentage of the tutorial programs that have so far been developed exhibit the kind of "skill" that is needed to make the tutorial approach to teaching as effective as it can and should be. Most tutorial software presents the information in an extremely linear and non-individualized manner and for too large and diverse an intended audience. They are not really designed to interact with the user and to continually modify the later presentation to reflect the needs of the student based upon the student's earlier responses. This is what a good human tutor would need to do to make a one-to-one tutorial approach effective, and its what a computer tutorial program must do as well.

For the uses of the computer described in this section the two most important components of the three component model mentioned earlier are hardware and software. This is because low quality hardware will not allow good software to be utilized, and a powerful machine may be wasted if effective software is not available for the purpose intended. Teacher training, while definitely necessary, is not as critical for this type of computer utilization since the program already incorporates the necessary teaching and/or drill and practice and therefore makes additional programming unnecessary. However, the teacher must be an effective diagnostician, expecially if the programs are to be used for remediation, and he/she must know here and when to make use of the programs within the curriculum.

Learning With Computers

The two categories of instructional techniques that fall within this use of the computer in learning are simulations and games. Simulations have been utilized for several years outside of education, with and without computers, in military, business, and governmental settings. In education, simulations have become increasingly popular, especially in science, mathematics, and the social sciences. A good example of a science simulation is "Odell Lake", developed as an ecological simulation for grades 4 through 6 by the Minnesota Educational Computer Consortium (MECC)(4). In this simulation, the student plays the role of a particular type of fish that lives in Odell Lake. The student is presented with a variety of situations that might occur in nature such as other fish coming into the student's territory; various types of food being made available; and the entrance of non-fish predators such as an otter. The student-fish must make decisions about how to react when these changes in the situation occur, and the decisions are considered by the computer program which then lets the student know if the response was an appropriate one or not and introduces a new change in the situation.

Two important positive characteristics of a good simulation, both of which are exhibited in Odell Lake, are allowing the student to make mistakes for which the consequences are non-threatening, and allowing the student to exercise some control over the learning process. Too often our educational situations are "right answer only" where students are strongly encouraged not to make mistakes. If, however, schooling is really intended to mirror the real world, we should allow students more opportunities to make mistakes and learn from them. Learning why something is wrong, and then being able to repeat the process with this experience as a guide is often a stronger learning experience than just having students trying to get the correct answer to a question from facts that have been memorized. The simulation allows the student to try different approaches in response to the given situation without having to fear the consequences of an incorrect action. In terms of control, simulations allow the student to become a decision maker rather than simply a receiver of information. It appears that this type of control is intrinsically motivating to the student and helps in making the simulation an effective learning tool.

A computer game differs from a computer simulation in that the game does not necessarily have to model a real world situation, and the learning that takes place in the game is usually picked up indirectly as the student attempts to develop a winning strategy in the game. A good example of a computer learning game is "Hurkle", also developed by MECC. The objective of the game is for the student to find the Hurkle (a small cartoon type character) after the Hurkle has hidden somewhere on the screen. The program randomly hides the Hurkle in an appropriate position on the screen, and the student uses the numbers representing the different positions to guess where the Hurkle is located. If the guess is incorrect, the computer will give the student a hint by printing something like "Go Southwest". The student then uses this information to try a second guess. This continues, with each incorrect answer eliciting a new hint until one of the guesses is correct. In this game, the student is learning about representing positioning on a line or a two dimensional grid in terms of numbered representation, not as an explicit part of the game but as a necessary part to find the Hurkle.

Simulations and games, while a better and more effective use of the computer's capabilities as an educational tool, do have limitations. In order for a simulation to be effective and useful, it must present an accurate model of the process or situation it is supposed to simulate. Many topics in science, mathematics, and the social sciences do have areas where reasonable models do exist. However, the amount of time and money needed to develop them is very high and so not as many good simulations and games are available as are drill and practice or tutorial programs. Furthermore, students must be cautioned that they are working with a model, not the real situation, and not all the effects that can occur in the real world situation can be accounted for in the simulation. Finally, it cannot be stressed too strongly that simulations should not replace real life experiences, but should enhance and augment these experiences. The best way to learn ecology is to do ecology, but multiple ecological experiences may not be available to all students in school. Ecological simulations can therefore be used to give the student the opportunity to experience such situtions that he/she would not be able to experience in real life. Neither will this type of program replace classroom teachers. The MECC materials come with detailed teachers' guides for developing multi-day lessons around the computer simulations that make it clear that the programs themselves cannot, in most cases, stand alone.

For the uses of the computer described in this section the most important ~~component~~ part of the three component model is the software; the next most important component is the hardware; and the least important component, although still necessary, is teacher training. Software is the most important because even the most sophisticated machine must have well prepared, realistic and motivating simulations and games to go with it. The hardware is not quite as important because, while special abilities such as high resolution color, graphics, and sound can greatly improve a simulation, even machines that do not have all of these capabilities can deliver good simulations if the programs are well written. As for teacher training, the emphasis is about the same as it was in the previous section. The teacher must be familiar with the program and where and how it should fit into the curriculum, but detailed knowledge of progarmming and computer hardware is not needed.

Learning About Computers

The computer application that is most generally thought of as falling within this use is that of computer literacy. This refers to a beginning awareness of what a computer system is and the components that make up a system; the languages that are used with computers; the basic operation of a computer; the impact of computers on our society in general and on particular occupations both now and in the near future; and an introduction to actual programming of a typical computer. Once computer literacy is achieved, several avenues of futher computer learning are available and this more advanced work would more properly be called computer competency.

There is one major problem with the implementation of computer literacy in the schools that teachers, administrators, and parents must face. This is the age old question of what must be removed from an existing curriculum if a new subject is to be incorporated. Several approaches have been used. One of the most popular is to incorporate the computer literacy program into an appropriate subject area course or sequence of courses, and this is usually the mathematics sequence. In this way, the students can learn about the computer as it applies to the ongoing study of the subject matter. A second approach is the development of a special minicourse on computers that groups of students rotate into and out of over the course of the year. These minicourses might last anywhere from three weeks to an entire semester, and are sometimes given as special courses during the summer or after school so that the regular curriculum does not have to be altered.

For computer literacy and competency the most important ~~component~~ segment for the three component model is the teacher training, followed by the hardware and then the software as relatively minor components. If a course in computer literacy or competency is to be implemented in a school, appropriate hardware is needed. But what is even more essential is the availability of a qualified and trained teacher. Unfortunately, this may be a serious problem for most school districts in the relatively near future since few colleges and universitites that prepare teachers include computer training within these programs. This problem will be discussed in more detail in a later section.

Learning About Thinking With Computers

Learning about thinking with computers is probably the most unconventional, but at the same time perhaps the most powerful of the various uses presented. In this role, the computer is used to help students develop new patterns of thinking that may assist them in many different learning situations that require logic and analysis.

The main proponent and artful presenter of this role of the the computer is Dr. Seymour Papert of the Massachusetts Institute of Technology's LOGO Laboratory. Papert is a self-confessed educational radical when it comes to his ideas of how computers and children should interact, and his underlying philosophy is based upon the work of the Swiss psychologist Jean Piaget.

Papert, while greatly influenced by Piaget, does extend and modify some of Piaget's ideas in his own model of the interaction of computers and children. In its simplest form, Papert is expressing the idea that the computer can be used to "concretize" many of the formal learning situations that students are presented with and in this way teach formal operational level concepts in a concrete operational level guise. He notes in his book Mindstorms (5), that our culture is very rich in some types of learning situations such as the concept of "a pair" (e.g., a pair of socks or a pair of shoes) but very poor in situations that require or develop sturctured thinking.

Structured thinking involves the process of dividing a large problem into smaller parts or components that can be easily handled on an individual basis and then combined to give a solution to the original larger problem.

One way Papert sees of implementing this learning of structured thinking is through the interaction of the student with the computer through the use of a computer language that is itself structured. That is, a language that allows the writing of a program to solve a relatively complicated problem by breaking the problem down into smaller and simpler components; constructing "procedures" or sub-programs to individually handle each of the components of the total problem; and then combining these sub-programs to produce a total program that solves the problem. Since BASIC was not developed to have this kind of a structure, Papert and others have criticized it as an inappropriate first language for someone learning about computer programming, in particular children, and propose the LOGO language as an alternative.

Central to LOGO is the LOGO "Turtle". First developed as a mechanical device that actually moved across the floor under the control of a student utilizing a computer, the Turtle has evolved into the picture of a small triangular shaped object on the display screen of a microcomputer. The position and motion of the Turtle is controlled by the student through the computer, and as it moves about the screen it can create a graphical display on the microcomputer's screen.

A simple graphic program may not seem to be "teaching" the student much, but this is not the case. In fact, it contains two very useful and important aspects. First, the student learns by trying out different possibilities and correcting any mistakes or omissions instead of simply being told what to do. For example, a student might start to create a square on the screen by using the command to the turtle "FORWARD 5" instead of the more appropriate command "FORWARD 100". He/she would quickly see from the results of the display graphic that this movement of five "Turtle steps" is much too short to produce a reasonable sized square and so a correction would have to be made with a larger number of "Turtle steps". Similarly, the student might follow the initial command "Forward 100" with the command "RIGHT 50" to tur. the Turtle 50 degrees to the right, but this would not result in the second side that is perpendicular to the first, and therefore the resulting figure would not be a square. Again, a correction for the angle would have to be made to produce a ninety degree angle between the two sides. The importance of allowing students to make decisions that might be wrong and learn from their mistakes when mistakes occur cannot be overemphasized. As previously noted, too often in today's educational setting mistakes are something to avoid at all costs and to forget when they do actually occcur instead of being treated as learning situations. The use of the computer in this role allows for immediate feedback, and for the student to discover and correct mistakes on his/her own without the onus of being "found out" and corrected by the teacher.

The second aspect of this situation in the opportunity the student is given to combine simple graphical programs like this one into combinations that produce much more complicated and detailed designs. It is the structured nature of LOGO that allows this building up of several simple geometric patterns into a more complex whole. For example, a student might use some simple designs like a rectangle and a triangle that have previously been produced with simple programs, and combine the individual programs to produce a program for a more complicated product such as a graphic of a house or a spaceship.

The three component model for this role of the computer has three equal components representing the essentially equal importance of hardware, software, and teacher training in its implementation. At the present time, in order to utilize a full LOGO type system, excellent hardware must be available (e.g., large memories, good graphics, disk storage, etc.). This may involve a much more significant investment as compared to the less expensive systems that may be used to implement some of the other uses of the microcomputer discussed in this section. The software component is just as important since a school would be reduced to having a powerful system available but with nothing to "run" on it without the LOGO (or similar structured language) software to use on the system. There is the advantage, however, that once the system software is purchased no additional software is needed.

Teacher training for working with LOGO or a similar structured language is really of a different type. Not only would the teacher need training with computers, but also work in Piagetian developmental psychology and the LOGO educational philosophy of allowing and encouraging student exploration. Because this teacher training is so non-standard and important, it must be considered on an equal footing with the hardware and software requirements.

Managing Learning With Computers

In contrast with the other uses of the computer in education that have been discussed, this use of the computer is indirectly related to student learning as opposed to being directly related. That is, this is a role in which the computer is used to help the teacher and/or administrator with much of the paperwork and organizational tasks that often take time away from actual teacher-student interaction.

There are several ways in which the individual classroom teacher can make use of the computer in this role. First, is the use of the computer in keeping track of grades and giving desired information about these grades such as averages and totals. Second, the computer can be used to generate test questions for the class in general, and special remedial questions for individual students based on their individual needs. Third, the computer can be used to keep track of the attendance record of the students in the teacher's class. On a school wide level, administrators can compile teacher reports with the computer to produce school and district information. Finally, the computer can be used by school administrators for many of their administrative duties such as class scheduling, budgets, availability and qualifications of substitute teachers, supply inventories, and similar tasks. In some schools computers have been used both for direct learning situations and for these types of administrative tasks. Careful planning is needed however, to allocate the computer resources to best benefit the students.

There are two alternate possibilities for the three componet model in this role of the computer. In the first, the teacher training component is the most important, and it is followed by the hardware as second most important and the software as least important. In the second, the software component is the most important, and it is followed by the hardware as second and the teacher training as the least important. The difference between these two models is the switching of teacher training and software. The reason for these two possibilities is that if the teacher has adequate training, then he/she can develop a great deal of the software to fit his/her specific classroom management needs, and so commercial software is not as essential. On the other hand, if the teacher does not have the training to do this, then commercial classroom and school-wide management software can be purchased. In either case the software (either teacher developed or commercially prepared) is the most important with hardware necessary but special capabilities not really essential.

Action Recommendations

The following section contains recommendations that educators should consider as their schools begin to use computers. The section in arranged in segments with general topics and recommendations within each topic. All recommendations may not apply to all schools but the listing is an attempt to consider many possibilities.

A. Development of School District Computer Guidelines

1. The school district should develop policy statements or guidelines for computer acquisition and/or use. The guidelines should consider:

a. The possible roles for which the computer systems can be used.

b. The problem of the generally mediocre quality of eductional software currently available.

c. The rapidly changing hardware market will require that equipment be reviewed to determine if older hardware should be replaced.

d. Maintence budgets should be 10-20% of hardware costs _per year_ especially if the equipment is being heavily used.

e. The extent which teacher in-service must occur.

All of these concerns should be considered as part of guidelines that school districts or individual schools develop as they integrate computers into their schools. Teachers, supervisors, and administrators should all take an active role in helping to formulate guidelines for classroom computer use.

B. Increase Personal Knowledge of the Uses of Computers

There are several methods by which educators can become more familar with microcomputers and their possible uses.

1. Self-Study

Several books and articles have been written on school computer applications and a sampling are listed in the bibliography of this paper. As with most subjects, however, there is a diversity of opinions about the most appropriate uses of computers in instruction. Educators are advised to read a variety of authors for a sampling of viewpoints. The major draw-back of self study, especially through books, is the speed at which the whole field changes. The publication lag time of books sometimes reduces their content to history, most noteably in the area of hardware.

Having a computer at home is, of course, a great advantage in increasing personal knowledge. Be sure to check with local district officals about possible special prices for educators or the loan of a machine during non-peak periods (holidays, summer vacations, etc.)

2. School Workshops

Workshops conducted by school districts or institutions of higher education can offer a second method by which educators can upgrade their skills. The usually limited time, however, of the workshops generally makes them more suitable for single or limited topic activities rather than in depth study of applica-tions of computers. For example workshops on the roles of computer use that do not require a large investment in teacher training such as; learning from computers, learning with computers, and managing learning with computers would be more appropriate than trying to develop indepth mastery of a topic such as LOGO in a short workshop. Workshops do provide a excellent vehicle to start orientation in computer applications that may be followed with a workshop series or, as discussed in the next section, coursework at institutions of higher education.

3. Courses and/or Degrees at Institutions of Higher Education

The institutions of higher education must take on two roles when it comes to the development of training in computer applications to instruction. First, the pre-service teacher must be brought up to the literacy level of computer use through appropriate coursework at the undergraduate level. This will probably mean a course in utilizing the computer both as an educational tool and as a tool for a professional. Specific applications to curricular areas may best be handled through the subject matter areas. Articles discussing these options are listed in the bibliography and represent varying viewpoints.

For inservice teachers and administrators, the workshop/short course model presented in the last section does offer a chance to start educators thinking and working with some applications of microcomputers. Several colleges and universities have expanded their computer application course offerings and some have degree and certificate programs available for teachers and administrators. These offerings vary from beginning literacy courses to specialized applications courses in subject areas and topics such as LOGO and interfacing microcomputers to videotape/disk systems. Not every educator will need this level of expertise, but computer science teachers, computer resource room directors, and district resource professionals should obtain training in more of the possible uses of computers in instruction and administration.

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Compute! The Journal for Progressive Computing, 625 Fulton St. Greensboro, NC 27403. A general information magazine with occasional articles about educational applications.

The Computing Teacher, Dept. of Computer and Information Science, University of Oregon, Eugene, OR 97403. A educational applications journal with a variety of good articles and classroom ideas. The November 1982 issue is dedicated to LOGO.

Creative Computing, 39 E. Hanover Ave., Morris Plains, NJ 07950. A general applications journal with special issues/columns on education. A good source of hardware/software reviews.

Educational Computer Magazine, P.O. Box 535, Cupertino, CA 95015. A recent introduction to the educational applications field. Some useful articles.

Electronic Learning, 902 Sylvan Ave., Englewood Cliffs, NJ 07632. An excellent source of "how to" articles for education. Major software houses are advertisers.

InfoWorld, 375 Cochituate Rd., Box 880, Framingham, MA 01701. A newspaper type publication which deals with the current changes in the R and D and marketing aspects of microcomputers

The Journal of Computers in Mathematics and Science Teaching, P.O. Box 4455, Austin, TX 78765. The journal presents a mixture of research and classroom applications articles dealing with math/science use of microcomputers.

Popular Computing, P.O. Box 397, Hancock, NH 03449. A general applications journal with occasional educational applications articles.

Selected Journal Articles

Anderson, C. "Teaching Computer Litearcy: Guidelines for a Six-Week Course for Teachers". Electronic Learning, Nov/Dec. 1981, p.30. An outline for a short course in computer literacy for novices.

Bitter, G. "Computer Literacy for Teacher Certification". Educational Computer Magazine, Jan/Feb., 1983, p. 22. The author presents areas that Arizona State uses for computer literacy and their approach to teacher training.

Bork, A. "Computers and Learning: Don't Teach BASIC". Educational Technology, April, 1982, p.33. Dr. Bork's views on the problems with BASIC as a first computer language and some alternative suggestions.

Bracey, G. "What the Research Shows". Electronic Learning, Nov/Dec, 1982, p. 51. A synthesis of some major studies dealing mainly with CAI type uses of computers. Positive overall effects are concluded based upon several studies.

Daiute, C. "Word Processing: Can It Make Even Good Writers Better?". Electronic Learning, Mar/April, 1982, p. 29. A presentation of some preliminary indications on the uses of word processors with students and a review of some packages used in the classroom.

Underhill, R. et. al. "Microcomputers in Educational Settings: Data for Searches", ERIC Clearinghouse for Science, Mathematics and Environmental Education, Information Bulletin No. 3, 1982. An excellent source for ERIC and CIJE references on microcomputer applications.

Kleiman, G., Humphrey, M. and Van Buskirk, T. "Evaluating Educational Software". Creative Computing, October, 1981, p. 84. Several aspects of software evaluation are presented and discussed with examples.

Luehrmann, A. "Don't Feel Bad About Teaching BASIC". Electronic Learning, September, 1982, p. 23. Dr. Luehrmann's response to critics of BASIC. Techniques for teaching BASIC in a more structured manner are presented.

Marks, G. "Computer Simulations in Science Teaching: An Introduction". The Journal of Computers in Mathematics and Science Teaching, Summer, 1982, p. 18. A discussion of the general area of simulations and considerations for use in science instruction.

Martin, K. and Riordon, T. (Eds.) "The Logo Center". The Computing Teacher, January, 1983, p. 66. A continuing column about the application of Logo to the classroom. Some interesting actvities on the use of text in Logo in this issue.

Papert, S. "Computers and Computer Cultures". Creative Computing, March, 1981, p. 82. A summary of Dr. Papert's views on the utilization of computers in eduction.

Ragan, A. " The Miracle Worker: How Computers Help Handicapped Students". Electronic Learning, Jan/Feb, 1982, p. 57. The article outlines some of the ways computers have been used with handicapped students and possible directions for the future. Several references to various projects are supplied.

Toong, H. and Gupta, A. "Personal Computers". Scientific American, December, 1982, p. 86. An excellent beginning article for a wide variety of auidences. The article discusses hardware components and applications in a non-technical manner.

Williams, G. "Structured Programming and Structured Flowcharts", BYTE, March, 1981, p. 20. A article outlining the method of structured programming especially as it applies to BASIC.