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ABSTRACT

The author cites the arrival of the information age and considers its implications for special education. He suggests that special educators must build their information management skills. Four specific applications of microcomputers in special education are addressed: tool applications (in which students use microcomputer technology as personal assistive devices), computer assisted instruction (drill and practice and tutorial programs), computer managed instruction, and computer literacy. The author considers the over use and improper application of drill and practice types of computer assisted instruction (CAI). The tutorial type of CAI is seen as very effective for learning disabled and other mildly handicapped students. Applications of computer managed instruction to individualized programing and program evaluation are noted. Computer use and computer awareness are explained to be major components of a computer literacy curriculum, and suggestions are made for educators to prepare their own computer literacy programs. Effects of the information age on the teacher's changing roles are examined. (CL)

THE SPECIAL EDUCATOR IN THE INFORMATION AGE

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THE SPECIAL EDUCATOR IN THE INFORMATION AGE

1.0 Introduction: The Umbrella Phenomena

The major purpose of this conference is to share information on the applications of the microcomputer to special education. Before we can discuss microcomputer applications, we must place the computer itself in perspective. Contrary to a lot of statements in the press and notwithstanding *Time* magazine's award (*Time* magazine, 1983) to the computer as the "machine of the year," the major phenomena we are witnessing is not a computer revolution. The major phenomena is the birth of the information age. We represent the last generation of the industrial age. The pupils presently coming to school are the first generation of the information age. When our present eighth graders take their place in society, 75 percent of them will be involved in information related industries. We are participating in a massive change in the very structure of society. For those of us whose life span will include the transition between these two ages--the industrial and the information age--this is indeed a time of wonder, challenge, and confusion. Like the adolescent caught between childhood and adulthood, we are experiencing that strange mixture of excitement and confusion as some of our traditional reference points dissolve and we try to determine which of the new directions has substance and which are shallow seductive facades.

By assigning the information age the role of umbrella phenomena, I in no way want to belittle or minimize the impact of

the computer. The computer is the major tool of the information age. By a serious study of the computer we can get glimpses of the nature of the coming information age and of the potential impacts on us as individuals and our society as a whole.

2.0 Broad Educational Implications

One of the lessons we have learned from 94-142 is that we are educators first and special educators second. We cannot hope to effectively serve the handicapped population if we lose sight of the overall mission of the educational profession. One of the primary impacts of the information age on the education profession as a whole is tied to a dramatic change in the way we approach the storage, retrieval, and application of information. We were raised in an age when much of the critical knowledge we gained in school could be contained in a few textbooks. Most of this knowledge stayed viable for years after we finished the formal education process. The rapid expansion of our knowledge base is such that the notion of the textbook as a source of information for future use is both obsolete and debilitating for the pupils taught under such assumptions. The challenge of all educators is to help our pupils survive in a world where the information they will need does not presently exist. The preparation of pupils to access and apply information that does not presently exist is a task that is new to most educators.

For us as special educators, we face the same problems as regular educators. We do not know for sure what the societal challenges will be for the population of special education students presently in our charge. The advent of the industrial

age created major changes in the lifestyle of individuals in the late nineteenth century. These changes had a profound impact on the quality of life of the handicapped in society. With the industrial age came the emphasis on asylums, state hospitals, and centralized facilities. Such facilities were necessary to take care of handicapped individuals whose traditional support systems had been dissolved or disrupted as the more flexible, rural life styles disappeared and previous caretakers moved to full-time employment in the factories.

What changes will occur as a result of the information age? We can only hypothesize. We can only gain glimpses. There are those who would suggest that the massive emphasis on technology and science associated with the information age will make society so complex that the power in society will be vested in that percentage of the population that has the knowledge and skills to manipulate information management tools such as computers. There are others who suggest that the technology will make life so simple that everything will be "user friendly;" that we will not have to think that hard; that the computers will take care of many of the stressful activities that presently occupy our time. This latter vision chills the blood of some individuals concerned about the intrusive nature of the information age. They view the abdication of our facilities to think and plan and search as an abdication of our humanity.

How can we prepare to fulfill our professional obligations in the face of such conflicting projections? As we receive these messages from the futurists, we should be wary of developing a

sense of inevitability and helplessness. We should view the process as an evolution and not a revolution. There is one clear course of action that is open to us. If we build our information management skills; if we develop our ability to manage the tools of the information age, we will be much better prepared to not only develop and assess future courses of action, we will, hopefully, be able to direct the course of the future.

It is the development of these skills related to the computer that is the major reason for our participation in this conference. The term commonly applied to the acquisition of these skills is "computer literacy." The possession, or lack of possession, of such computer literacy as it applies to our own profession will determine whether we are passive recipients or active participants in the information age.

3.0 The Learning Process

It has been a well documented fact that many of the handicapped individuals in our society assume their greatest visibility during their school years. There have been a number of explanations given for this. Some would say it is a function of our statistical processes in that we tend to keep better statistical data on school age pupils than other members of the population. Some skeptics would say it is understandable in view of the special education profession's propensity for empire building. I prefer to think that a major reason for the visibility of so many handicapped individuals is due to the fact that we have placed them in a substantial learning environment. Many of these individuals are handicapped because they do not

adapt to the learning process as well as their peers.

A developing characteristic of the information age is an emphasis on a life-long learning process. One of the more perceptive observers of technological impacts on society is O. K. Moore, the developer of the "talking typewriter" in the middle sixties. With regard to the impact of the new technologies on society, he and Andersen (Moore and Andersen, 1969) made the following observations:

> We think that one important result of this technological leap is that we are in transition from what we have called a "performance" society to a "learning" society. In a performance society, it is reasonable to assume that one will practice in adulthood skills which were acquired in youth.. . . In contrast, in a learning society, it is not reasonable to assume that one will practice in adulthood the skills which were acquired as a youth. Instead, we can expect to have several distinct careers within the course of one lifetime. Or, if we stay within one occupational field, it can be taken for granted that it will be fundamentally transformed several times. In a learning society, education is a continuous process--learning must go on and on and on. Anyone who either stops or is somehow prevented from further learning is reduced thereby to the status of an impotent bystander.
>
> We assume that the shift from a performance to a learning society calls for a thorough-going transformation of our

educational institutions--their administration, their curricula, and their methods of instruction. Education must give priority to the acquisition of a flexible set of highly abstract conceptual tools.. . . What is required is the inculcation of a deep, dynamic, conceptual grasp of fundamental matters--mere technical virtuosity within a fixed frame of reference is not only insufficient, but it can be a positive barrier to growth. Only symbolic skills of the highest abstractness, the greatest generality, are of utility in coping with radical change. (pp. 583-584)

4.0 Special Education Applications of Microcomputers

With the broad implications of the developing information age in mind, I would like, now, to turn to the specific applications of the microcomputer in special education.

In special education there are four major areas of application. These are: (1) tool applications; (2) computer assisted instruction (CAI); (3) computer managed instruction (CMI); and (4) computer literacy.

4.1 Tool Applications

The tool applications I particularly want to address in special education are those where the pupil uses microcomputer technology as a personal assistive device. Examples of this would include the gifted child using the computer to help solve a mathematical equation; the learning disabled child using word processing and related programs to analyze spelling and grammatical errors; the visually handicapped pupil using

electronic aids to translate print into synthesized speech; the deaf child and the speech impaired pupil using the microcomputer to translate typed-in information into synthesized speech, and the physically handicapped child using microcomputer technology to activate muscles which had damaged neural connections.

These electronic personal assistive devices have made dramatic changes in the quality of life of a number of our special education pupils. This is an exciting and growing field that has already yielded rich returns for comparatively modest investments. As Vanderheiden (1982) observed:

> The past few years have witnessed a tremendous increase in the number of individuals and small groups involved in the development of special aids for disabled persons. Microcomputers have given individual designers who don't have access to extensive laboratory and production facilities, the capability of developing sophisticated electronic aids. (p. 136)

The major contribution of these electronic aids has been to the sensory and motor handicapped members of our special education population.

4.2 Computer Assisted Instruction (CAI)

Without wishing to detract or minimize the value of the personal assistive devices I have just referred to, it should be noted that the special education classifications that benefit most from these devices represent approximately 7 percent of the school-age handicapped population. The visually impaired, the deaf, the hard of hearing, the crippled and other health

impaired, and the multiply handicapped comprise approximately 7 percent of the school-age handicapped population. The remaining 93 percent is made up of the learning disabled, the speech impaired, the mentally retarded, and the emotionally disturbed (Report to Congress, 1982).

Of primary concern for the majority of the special education pupils in our care will be the relationship between the instructional applications of the computer and the needs of the special education pupil. The most prevalent application of the microcomputer in instruction is in computer assisted instruction (CAI). CAI programs are generally discussed in two categories: drill and practice, and tutorial programs.

4.2.1 <u>Drill and practice</u>. Drill and practice CAI programs are the most used and probably the most criticized of the different types of CAI products. Some of the criticism is justified because many of the poorer software programs are drill and practice programs. Beginning CAI software programmers cut their teeth on drill and practice programs because they are short and often do not require sophisticated computer programming skills. The result has been a large volume of poorly written products that confuse the naive user, anger the sophisticated user, and embarrass the authors as they become more skilled in CAI development.

Drill and practice programs are the "flash cards" of CAI and to the extent that there is a place for flash card-like activities in the classroom, so there is a place for good drill and practice software. While few people would question the need for drill and practice in subject areas such as typing, some do

object to the stimulus response type of instruction in other curriculum areas. It should be remembered that to function at higher cognitive levels, certain preliminary skills have to be automatic. Pupils cannot do quality creative writing if they are consciously fumbling with the subskills of spelling and punctuation. Long division cannot be done quickly and accurately if the subskill of subtraction is not mastered. Drill and practice programs have an important place and are most appropriately used (a) for subject matter that needs to be well mastered to facilitate the effective performance of higher level skills; (b) after the concepts related to the skill have been taught, and (c) just prior to the application of these skills to higher levels in the curriculum hierarchy.

The problems with drill and practice CAI are mostly problems of teacher management rather than computer related problems. Drill and practice activities that are used as a substitute for the necessary teaching of the underlying concepts, and drill that is not followed by meaningful applications of the skills are inappropriate uses of drill and practice, regardless of whether a computer is involved or not. The issues relating to the inappropriate use of drill and practice were well summarized in a study (Alderman, Swinton, & Braswell, 1978) of the effectiveness of a CAI arithmetic skills curriculum. In concluding the study, the authors noted that:

> The results do not call the curriculum itself into question, but instead, they challenge a fundamental assumption of any drill and practice approach. That students bring with them

> to the drill experience some prior understanding of the exercise topics. These results would seem to be a strong argument for closer integration of classroom teaching with any curriculum that provides drill and practice, and for a careful analysis and assessment of the prerequisites necessary for children to obtain maximum benefit from a drill-and-practice curriculum. Perhaps with exposure to fundamental concepts and models prior to extensive drill-and-practice, such curricula can exert even greater positive impact on student achievement. (p. 31)

The overlearning of skills is an important practice in special education. We have been highly dependent on good drill and practice activities. The microcomputer holds the promise of adding considerably more instructional resources. Herein lies a dilemma. The more attractive and the more effective, the more a drill and practice activity frees the teacher, the more a teacher will be inclined to overuse it. The more a teacher overuses drill and practice, particularly as a substitute for tutoring in the concepts underlying the drill and practice activities, the smaller the contribution drill and practice will make. A good CAI drill and practice program is like a sharp axe. When properly applied in skillful hands, it will make a major contribution. Improperly applied by those who do not fully understand its role and contribution in the instructional process, it will make a mockery of good instructional practices.

4.2.2 <u>Tutorial programs</u>. One of the characteristics we generally attribute to the good special education teacher is that of an insightful, empathetic, and effective tutor. CAI tutorial

programs should then be of major interest to the special educator. CAI tutorial programs hold considerable promise for the special educator for two very important reasons. First, the majority of special education pupils are now served in regular class settings with resource room or consultant support. This means that the majority of instruction must be delivered in classroom environments where the teacher/pupil ratio is not as advantageous as it often is in separate special education classes. Any technology that has the potential to increase the level of personalized instruction in these environments should be thoroughly explored.

Secondly, the largest population of special education pupils is the learning disabled. There has been a dramatic increase in the percentage of handicapped pupils classified as learning disabled. In the 1976-77 school year, nationwide, we classified approximately 800,000 pupils as learning disabled. In the 1980-81 school year, we classified approximately 1.5 million pupils as learning disabled--an 84 percent increase. Very little computer software is being developed specifically for special education populations. For the mildly handicapped and the learning disabled in particular, we will, as we have always been, be highly dependent on the adaptation of products designed for regular classrooms. In the large volume of tutorial software presently being developed, we will hopefully, find a significant number of products that will be effective with our large learning disabled pupil population.

There are three different types of tutorial programs. The most common approach to a tutorial program is to use the theoretical structures and procedures from programmed learning materials. In a programmed learning approach the subject matter is organized into instructional sequences, usually in a hierarchical manner. These programs stress active responding by the student and make extensive use of feedback and the branching to previous material or alternative sequences when student mastery criteria are not being met on specific objectives.

Simulation programs represent another approach to tutorial programs. These programs typically include some elements of the programmed learning tutorial approach. Central to the program is usually some simulation of an environmental event. It may be a chemistry experiment, movement of travelers on the Oregon Trail, or the prediction of a volcanic eruption. Such simulation of real events can create a very powerful instructional experience. One of the best examples of the value of simulation programs is the use of flight trainers. When used as an alternative to actual airplane flying in the initial stages of instruction, the flight trainer results in large savings in personnel time, equipment costs, and pilot lives. Simulation-based tutorials are invaluable in situations where the real life event is too expensive, too dangerous, or difficult to create or observe.

Artificial intelligence-based tutorial systems are the third type of tutorial program. In these programs the researchers attempt to simulate the actions of an expert human tutor. A number of these types of programs, usually referred to as intelligent tutoring systems or intelligent computer assisted

instruction, exist in medicine, geology, chemistry, and education.

One of the most popular artificial intelligence based approaches is what is known as the knowledge-based expert system. The intelligence of the human tutor is built into the system through the identification of specific rules or heuristics. Typically, these rules are identified through observing or interviewing an expert. Some of these systems will contain over a thousand separate rules that were identified after months of interviewing and observation of experts. These programs are expensive to develop and the memory and speed requirements of the host computer are such that few were designed for microcomputers. However, within the last few years several intelligent tutoring programs have been transferred to microcomputers.

I would like to further exemplify the difference between the traditional approach to CAI and intelligent tutoring systems.

We at Utah State University are presently completing an interactive videodisc program to assess the math skills of mildly handicapped pupils. The system consists of a microcomputer, a videodisc, and a touch sensitive color monitor. Attached to the microcomputer are two disc drives and a printer.

The computer presents questions in audio and color video on the screen. The pupil responds by touching an object or answer alternative on the screen. The computer monitors pupil responses, and when a pupil makes three consecutive errors in one curriculum strand, branches to another. The microcomputer can be programmed to conduct the assessment in English or Spanish. The

logic is, at present, a traditional approach in that decisions are made based on a standard formula, e.g., branch to another strand after three consecutive errors.

After we collect sufficient knowledge relating to how different pupils perform in different curriculum areas, it will be possible to make the decisions much more "intelligent." The computer, rather than branching after three errors, would assess the probability of future questions being productive. This would be done by collecting information on the prerequisite skills the student brought to the testing, performance to that point, and other variables that were related to performance. This pupil information would be compared with the knowledge stored in the computer on the behavior of pupils previously tested and decide the probability of further productive testing in that strand hierarchy.

In a similar manner the computer could sample the pupils' performance on selected English and Spanish items and decide if the pupils should be tested in English or Spanish.

One intelligent tutoring system that has obvious implications for special education is the "Buggy" program (Brown and Burton, 1981). This program helps tutor an individual in the identifcation of common arithmetic computational errors. Buggy and other intelligent tutoring systems offer promise for the following reasons:

1. They tend to focus on very critical skills. While not comprehensive like traditional programmed learning based tutorial CAI programs, the skills that they do focus on are usually gateway skills.

2. Because they tend to emphasize the errors human beings typically make in conducting a task, they hold considerable potential for special educators because we have a strong interest in the diagnosis and treatment of errors.

3. The development of an intelligent tutoring system requires an extensive study of tutor/pupil interactions. Information of this kind will be useful not only for the development of intelligent tutoring programs, but should also provide direction for other non-computer interventions.

4.3 General Implications of CAI

A few general comments regarding the total field of computer assisted instruction are in order. First, I become concerned when I observe educators relatively new to computers becoming overly impressed and intimidated by CAI to the extent that they start to lose confidence in their present instructional techniques. There is nothing in the research literature to suggest that computer assisted instruction is the best form of individualized instruction. Indeed, the literature (Hartley, 1977) suggests that while computer assisted instruction is generally better than other approaches such as programmed learning and individual learning packages, it usually comes in second to structured tutoring approaches such as peer, cross-age and aide tutoring.

Because engaged time has one of the best correlations with achievement, the lack of equipment is still a major problem. The equipment will surely come; however, until it does, we must explore alternatives to the traditional one student per computer

configuration. At Utah State University we are presently developing software for the junior high resource rooms and feel that extensive engaged time can be achieved with a single microcomputer and printer if used for assessment, monitoring, and the generation of personalized worksheets.

For many people computer applications in education are synonymous with CAI. This misconception is unfortunate for at least two reasons. First, it fails to recognize the issue of computer literacy and the need for the computer to be seen in its full societal role as a tool of the information age. Second, computer assisted instruction is a developing area and subject to considerable variation in the quality of its products. To advocate or criticize all computer applications in education on the basis of the present state of the art of CAI would be most unwise. Advocates of CAI must realize that we will do a disservice to school pupils and CAI by suggesting that CAI is presently the best and only approach to individualized instruction. Critics must be sensitive to the fact that CAI is still in its infancy, and to condemn it on the basis on its poorer products may restrict the development of the field and our chance to learn what contributions are possible.

5.0 Computer Managed Instruction (CMI)

Of the several applications of the computer to education, computer managed instruction (CMI) is probably the least visible and least discussed. While the fortunes of CAI have fluctuated, CMI has been making quiet but substantial contributions to

education. With its emphasis on the management of instruction-related information rather than the direct teaching of pupils, CMI may be the most cost effective example of the application of computers to instruction.

A basic responsibility of all teachers, and the special education teacher in particular, is the development of an individual program for each child, and the monitoring of the child's progress through that individual program. The use of the computer to support the prescription and monitoring of individual programs of study represents one of the oldest and most extensive applications of the computer in education.

Burke (1982) has defined CMI as:

> The systematic control of instruction by the computer. It is characterized by testing, diagnosis, learning prescriptions, and thorough record keeping.

We can see in this definition a clear and strong relationship between computer managed instruction and the special educator's IEP responsibilities.

I became most impressed with the potential of CMI after serving as an external evaluator for the GEMS Project. GEMS is an anachronym for Goal-based Educational Management System, and it was developed in Jordan School District, a large, rapidly-developing, urban school district south of Salt Lake City.

The district described the project as a computer supported management system developed to support diagnostic prescriptive teaching for mastery learning. Each curriculum was structured into strands, goals, and specific objectives. For example, GEMS reading contained strands of phonics, structure, vocabulary,

comprehension, study skills, and affective reading. Within these strands were some 200 goal units. Each goal unit was further divided into specific objectives. As the students completed units of study, they were posttested and if mastery was achieved, they moved on. If mastery was not achieved, alternate learning strategies were identified and implemented. Because the computer contained all the pre-assessment and post-assessment information on each pupil, the teacher could call for a range of computer reports on the progress of individuals or groups. The district (Stevenson, Edwards, & Bianchi, 1978) described the purposes of their computer system as follows:

> . . . a computer retrieval system has been instrumental in the development of GEMS reading by providing an essential research base as well as efficiently monitoring the work of more than 20,000 students.

The reference to the computer providing an essential research base reflects a major value of CMI. By analyzing the progress of students through the specific curriculum units, staff at the school and district level were able to identify areas of weakness. The information was used to remediate these weaknesses. Alternate teaching strategies were developed, curriculum sequences were revised, instructional materials were changed, and in-service training programs were developed. The effect of these changes were then monitored by using the computer to analyze the achievement gains of pupils. Ineffective practices and materials were replaced. What resulted was a continuous process of intervention, evaluation, and program

revision. In the GEMS project, the effect of this process was substantial. Within a two-year period, the average reading comprehension score had jumped 10 percentile points, from 45 to 55, and the average vocabulary score jumped 21 percentile points, from 45 to 66. One of the impressive findings in the data was that all populations, both the high performing pupils, the Title I, and those with learning problems benefitted.

The GEMS project was able to demonstrate impressive accomplishments at a modest cost and has been replicated in a host of other districts and states. It must be remembered that the presence of computerized banks of data on pupil achievement is of little value by itself. There must be a commitment by the teachers and administrators to use the data to help direct improvements. This sense of self-evaluation and professional accountability was present in the Jordan School District staff, and was <u>the</u> major factor responsible for the success of GEMS. The computer was a tool--a tool that was used with skill and sensitivity to make a significant improvement in the achievement levels of thousands of pupils.

One of the interesting aspects of the GEMS project was the generalizability of the model, which followed a classical computer managed instruction model and was designed basically for all students. The characteristics of the model and its implementation were such that it followed very closely the requirements of an individualized educational program.

I would like to dwell a little longer on the observation that the success of a CMI program is highly dependent on the manner in which the staff view the data generated by such a

program. There are two ways we can approach that data. We can view the data as an end product in itself. For example, we have a requirement under 94-142 to monitor individualized education programs. The presence of data is evidence that monitoring has occurred. The other alternative is to view the data not as an end product but a stepping stone to program improvement. We have in special education a large number of computerized programs designed to facilitate the management of individualized education programs. Some of these computerized IEP programs have been instituted to reduce the paperwork burden.

We should remember that when a special educator complains about the paperwork burden of the IEP, there are at least two possible interpretations. One interpretation comes from the teachers that have a sense of accountability and conduct the necessary record keeping for the establishment of individualized programs of study and the monitoring of these programs. An interpretation of the extra paperwork complaint from such teachers is essentially that they have an effective record keeping system already installed and they do not wish to be bothered with additional record keeping.

Another interpretation of the extra paperwork complaint comes from the teacher who is not conducting functional record keeping and feels highly uncomfortable with the accountability pressures associated with IEP paperwork. The interpretation of the extra paperwork complaint from this teacher is essentially one of "I don't want to be involved in any activities that will force me to be accountable for my instructional behaviors."

Given the existence of these two approaches, it should come as no surprise to us that the implementation of some computerized IEP programs have not facilitated the professional accountability spirit behind 94-142. In some implementations the computerized IEP has facilitated the segregation of record keeping and classroom practices.

One advantage of many of the computerized IEP systems is that, for those who care to look, there is some very interesting information to be found. Some of the skeletons in our professional closet become alarmingly visible. We have, as a profession, some large gray areas in our practices relating to identification, assessment, placement, and program preparation. It has little to do with 94-142, but reflects rather the infant nature of special education as a discipline. If you care to analyze some of the computerized IEP records and compare them with classroom practices, you will find in certain school districts a rather alarming number of inconsistencies. You will find that screening information does not always match assessment procedures; that assessment information is not always consistent with pupil classification and program recommendations; and you will find that classroom practices are not always consistent with IEP program information.

It is very clear that the computerized IEP does not always function as an implementation of the information age. It is somewhat analogous to a stone-age citizen using an outboard motor as an anchor for a raft. What we have done is move our paper records into the computer. We are treating the computer as an unintelligent file cabinet. The computer is perfectly capable of

determining the degree to which the process of screening, assessment, classification, placement, and program implementation is a generally rational process. One would hope that the reason we have failed to use the intelligence of the computer to monitor the rationality of our activities is due mainly to our naivete regarding computers and not our lack of interest in evaluating the validity of our decisions. Having seen computer managed instruction make a significant difference in the quality of life for thousands of children, I become saddened when I see computers being used as final resting places for valuable information that could be used for program improvement. In many ways the unopened file cabinet is preferable to the computer storing of information that is never used. At least with the unopened file cabinet, we were not fooling ourselves that we were doing something significant or professional.

6.0 Computer Literacy

In the previous applications we have discussed, the computer served as a tool, either as a personal assistive device, as an instructional aid, or as an information management device. In computer literacy the computer becomes a part of the curriculum. Computer literacy as a concept is still developing, and it is sometimes difficult to gain consensus as to the critical attribute of this concept. One of the most concise definitions is that presented by Hunter (1983) and defines computer literacy as "Whatever a person needs to be able to do with computers and

know about computers in order to function in an information-based society."

One of the primary roles of the special educator is to identify those critical survival skills that individuals need as they move into adult society. In analyzing the needs that an individual will find necessary to effectively function with computers in an information-based society, we find skills, knowledge, and attitudes important components of those needs. Another consideration with regard to these needs is that they will not be static, that they will vary with time, place, and the individual.

There appear to be two major components of a computer literacy curriculum--computer use and computer awareness. Computer use is concerned with the mastering of technical skills necessary to interact with computers. The second element, computer awareness, is concerned with the development of understanding and attitudes that will allow the individual to function effectively in a computerized society. Both of these components represent challenging instructional problems for the special educator. The teaching of computer science is a major challenge because of the lack of resources in the form of trained staff, equipment and a well structured, validated curriculum. The teaching of computer awareness is also complicated because of the lack of resources and the often subtle nature of the learning process. The teacher already intimidated by computer technology will have considerable difficulty teaching the attitudinal objectives associated with computer awareness.

The major substance in a computer literacy curriculum does not lie in mastering some specific hardware manipulation skills. If it were just a motor skill requirement, we would indeed be fortunate because, generally, special educators have done well in the teaching of specific motor skills. The central thrust of computer literacy has to be concerned with the individual's ability to access and apply computer stored information. The skills that we presently use in moving information from person to person are insufficient for moving information between individuals and computers.

Before information can be processed by a computer, it has to be structured in a form acceptable to the computer. This structuring requires that information be sequenced and that the outcome of all decision points be considered and planned for.

One way to determine if the information is structured for computer interaction is to see if it can be represented as an algorithm. This procedural, or algorithmic thinking, is the gateway skill for computer programming. Procedural thinking is also necessary for informed interaction between the user and the computer. Individuals who understand algorithmic structures are in a much better position to meet their own needs as they interact with computers. The uninformed individual is forced to interact in a reactive manner and is usually at the mercy of the software. Adaptions to individual needs that were not considered or well planned by the software developer are not available to those who do not have the broad algorithmic concepts underlying much of our software design.

The fact that many of the individuals who have seriously studied priorities in a computer literacy curriculum have identified this procedural thinking as an extremely high priority gives no great comfort to the special educator. Those of us who have worked with the mildly handicapped are all too familiar with the difficulty these pupils have in abstract thinking. It is very clear that in this particular area the process of integrating the mildly handicapped child into the mainstream curriculum is going to present some major challenges to special education teachers. For the moderately and severely handicapped, we also face similar challenges. Many of the daily personal survival skills that we included in our curricula--skills related to shopping, use of transport, personal budgeting--are all changing as computerization begins to impact on every facet of community life.

Up to now we have considered computer literacy from the special education pupil's point of view. What about the special education teacher? We, like the pupil, have to build our own computer literacy skills. Some of these skills will be the same as our pupils. Others will be peculiar to our own particular role. This is an area of considerable confusion for many special education teachers. Where to start?

I would like to suggest that you prepare your own individual computer literacy program. The program should have two components: (1) a listing of skills you wish to acquire, and (2) a listing of activities that will facilitate the development of these skills.

You should list your skills in order of priority. The following is an example listing of a set of skills in order of priority:

1. Develop competency in a word processing program and use word processing for communication with parents and for managing classroom assignments.
2. Develop competency with a simple data base management system and apply these data base management skills to classroom record keeping.
3. Screen, select, and evaluate CAI software.
4. Learn some elementary computer language skills.

You will notice that I listed exprience with a computer language as a relatively low priority. There are some teachers who feel that they will not be able to do anything with their computer unless they learn a computer language. This is an extremely erroneous notion. We have a wealth of very powerful software available to the classroom teacher. Much of this software can be used by individuals with no computer programming experience. Word processing software and data base management software are extremely practical, flexible classroom programs that can be learned quickly and require no computer programming experience.

Some computer programming experience has value, but not for the purpose of having teachers write their own computer programs. Few teachers will have the time to develop the skills needed to prepare quality computer programs. It is much more important that the teacher be an intelligent user of existing quality software programs. For the teacher that has the aptitude, time,

and interest to develop computer programming skills, then by all means develop programs. The field is in need of programs developed by individuals who are both good teachers and good computer programmers.

7.0 Computers and the Changing Role of the Teacher

Because much has been made of computer assisted instruction, there are some individuals in the teaching profession who feel that the computer represents a threat. There is nothing that I have observed in present practices or future trends that suggests that this is even a remote possibility in the near future. If anything, I think the heavy involvement of computers in the classroom will make the teacher an even more precious commodity. Let us look at this issue in a little more detail by examining two of the major activities of the teacher, namely, the role as decision maker and the role as tutor.

At present, virtually all of the successful CMI programs are designed to support the teacher as decision maker. This point can be made by comparing the traditional, standardized district-wide group achievement testing and CMI generated achievement monitoring. Standardized group testing often diminishes the role of the teacher as decision maker. Standardized group testing data is often late and not tied directly to the materials and specific curriculum objectives in a classroom. It often has little decision making value for the classroom teacher. CMI pupil achievement information is provided quickly and is tied closely to the specific objectives and instructional practices in

the classroom. It is decision making information that is timely and relevant. The role of the teacher as decision maker is enhanced by such information.

With regard to computer assisted instruction programs replacing the classroom teacher, all the research information points to the contrary. CAI has generally done much better in a supplementary rather than an exclusive role in instruction. The involvement of CAI may modify some teacher activities but will certainly not diminish the importance of the teacher. If anything, we have created an even more complex instructional environment because teachers, in order to be able to select and intelligently apply CAI software, need all their present skills plus those skills associated with this new technology. I think we will have a problem holding teachers. The more teachers build their computer skills and the more they become adept at information management practices with these new technologies, the more attractive they will become to business and industry. We can anticipate an even larger drain as more teachers look to other professions that will pay more for their technical skills.

As I look ahead and try and predict the developing role of the special education teacher in the information age, I see exciting new directions with considerable substance. I feel that the highest immediate priority is the development of computer managed instruction. Computer managed instruction is a decision making and planning tool. Such planning has to precede the application of computer assisted instruction. I feel computer assisted instruction is, at this point in time, somewhat undeveloped to achieve an immediate contribution to both special

special and regular education. I think, in the long run, as we learn more about the instructional process, CAI will indeed make a major contribution.

8.0 Conclusion

I would like to close with an observation on our role as individuals. Robert Mager (1972) once made the observation that an educator should regularly experience the role of the learner to remain sensitive to those instructional behaviors that support and confound the instructional process. For most teachers the development of their own computer literacy skills will place them in the role of the learner. For the educator committed to the instructional caste system, this learning role will be aversive. Hopefully, the professional special educator will view the learning role as an opportunity--a chance to share in the excitment, a chance to serve as an enthusiastic role model, a chance to learn from pupils, a chance for teacher and pupils to glimpse the future as partners in the same learning venture.

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