Preliminary analysis of covar
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CAI, including attitudes towa
William Cole dissertation - P
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ariance indicates statistically signifi-
students in mathematics areas treated by
ward mathematics (See description of the
Page 26). The secondary students
a mathematics lesson at the Mott Lab.

3. Rather than assuming the existence of prerequisite skills in basic language arts and mathematics, student proficiency is assessed and deficiencies treated.

4. The program assures that the student receives instruction and counseling in self-assessment, realistic career planning and the techniques of job getting.

5. Rather than setting the same goals or no goals for students in office education, the program assures that each student may achieve a first level of competency by dealing with selected concepts at the beginning of student enrollment and by individually prescribing instructional units.

6. The student is not restricted to learning only through classroom instruction, but has the opportunity to learn at his own rate in a variety of instructional settings.

Five occupational choices are the basis for the initial program design: Clerical-clerk, Clerk-typist, Clerk-stenographer, Receptionist, and Secretary-filing. For each of these occupational goals there is a prescribed sequence of instructional units.

Performance objectives, which served as the framework for planning the instruction, were developed for each of the units together with appropriate pre and posttests. A student may test out of any unit in which he can demonstrate the required level of proficiency. The units are not limited to any single method of media. Some involve a minimum of independent work combined with group instruction, while others may require only independent study through CAI or other programed materials.

Before entry into the specific instructional sequence, every student is required to take instruction in basic vocational and clerical concepts and to demonstrate the requisite level of proficiency in basic language and computational mathematics skills (Remediation is provided for those who need it).

Cooperative work experience is recommended for all students and final instruction in post secondary planning is required to complete the program.

CLASSROOM MANAGEMENT

TOPIC SELECTION

The team members are a school district social worker and a district psychologist. Noting that much of their time is spent helping teachers cope with problems related to classroom management and disruptive student behavior, the team concluded that there is a definite need to develop instruction that would give teachers a working knowledge of a variety of behavior modification techniques. Such a program would make the teachers' job easier and free counselors and school social workers to spend more time counseling individual students.

OBJECTIVES

The goal of the Classroom Management Team is to provide teachers with techniques and procedures which can be employed to promote more appropriate social functioning in the school setting. The terminal behavioral objective is:

> The teacher will be able to analyze given classroom situations, identify specific target behavioral and write or identify a behavioral prescription (using behavioral learning theory and psychological concepts) for the specific classroom situation.

AUDIENCE

Beginning teachers, student teachers, experienced teachers in in-service training.

UNIT DEVELOPMENT

The team has collected reference materials and has corresponded with other researchers doing related work. It has consulted with specialists at Michigan State University and The University of Michigan as well.

The team has developed introductory units on defining effective rules and on positive reinforcement. It also has developed a collection of

problems which may be used by the teacher (who is in this case the student) to develop solutions to similar problems in his own classroom.

DEVELOPMENTAL TESTING

Pretests and posttests have been developed for both of the introductory lessons.

LANGUAGE ARTS

TOPIC

The Language Arts Team began its work by developing performance objectives in writing, listening and reading for kindergarten through grade twelve. Beginning with the recognition of upper and lower case letters, the team defined a cognitive structure for the writing skills which included 32 stages or steps leading to the fin objective of writing coherent and well developed paragraphs.

Originally, the team planned to use this framework as a guide for developing curriculum for all grade levels, but it soon became apparent that such an ambitious task could not be completed within the time limits of the project. Analyzing the resources of the team, the nature of computer assisted instruction and needs of Waterford students, the team concluded that its efforts could be most profitably directed toward designing developmental and remedial instruction in the basic language arts skills for under and low-achieving secondary students.

UNIT DEVELOPMENT

The team has completed a semester program designed to provide instruction, drill and review in the basic skills of grammar and sentence structure requisite to the development of proficiency in written language.

The CAI program is divided into 21 units. Each unit contains a leveling pretest and one to five days' lessons. Each day's lesson is written on three levels of difficulty to allow for individual differences in learning rate and achievement. Each lesson at each level contains a tutorial file and an application file. The tutorial file is designed to teach a given concept and the application file provides drill and practice in the concept.

The entire program is prefaced by a general diagnostic test to determine which of the units the student needs. On the basis of this test, the student's instructor prescribes and sequences the required instructional units. Student entry into each instructional unit is accomplished through a leveling pretest which determines the level of difficulty of the first day's lesson. The level of the second and subsequent lessons within a unit is determined by the student's performance on the application file of the preceding day.

ILLUSTRATION OF LEVELING

The program also includes five review units which may be scheduled at the instructor's discretion.

The language arts program has been loaded on the I-71 system and is now being used in the pilot Communications and Mathematics Skills Program (CMSP) at Mott High School. The language arts lessons are also used in the Adult Basic Education program and in the business team's Computer-Managed-Instruction program.

DEVELOPMENTAL TESTING

Many of the units were tested in a paper and pencil format and revised. Several were tested "on-line" and revised. These were used as guides for the development of other lessons.

Following the pilot on-line run of the entire program, a final revision and lesson evaluation will be made.

MATHEMATICS

TOPICS

A. Estimation, approximation, fractions, decimals and percents - 150 lessons each on 3 levels of difficulty.

B. Time Telling - 20 lessons incorporating visual displays and audio instruction.

C. Measurement - 15 lessons incorporating visual displays.

D. Matrices - 9 lessons incorporating visual displays.

OBJECTIVES

Definite terminal and intermediate objectives have been developed for each unit.

AUDIENCE

The units on estimation and approximation, measurement, fractions, decimals and percents have been incorporated into the Communication and Mathematics Skills Program (CMSP). The units on estimation and approximation are also being used for later elementary students (grades 4,5, and 6) and the units on fractions, decimals, percents and measurement are being used for junior high students and Adult Basic Education. The time telling units are designed for early elementary students (grades 1, 2, and 3). The matrices lessons are written for advanced algebra students in grades 11 and 12.

UNIT DEVELOPMENT

Flow charts were developed for each instructional sequence. Terminal and intermediate objectives were stated in behavioral terms and appropriate prerequisite and criterion tests were developed with the lessons. All lessons were first written in a format that could be tested and revised before the final computer encoding. All lessons have been revised at least one time. Many have been revised several times. Thirty estimation and approximation lessons have been tested "on-line" and revised.

In addition to the CAI programs, the team has also developed several single concept instructional management booklets. The booklets are designed to help students learn a given concept by working through a series of auto-instructional lessons. Working independently, the student tests himself after each learning activity and proceeds to the next activity on the basis of his test score. The materials used in these programs include non-CAI lessons as well as portions of the L. W. Singer mathematics program.

DEVELOPMENTAL TESTING

A general objectives test for estimation and approximation was designed and administered to 4th, 5th, 6th, 9th, 10th and 12th graders. It was item analyzed and furnished additional directions for unit development. Unit pre and posttests and diagnostic tests have been devised for all sequences.

All lessons have been tested in a paper and pencil format at least once and revised. Many of the units have also been tested on-line and revised. The Stanford Achievement Tests are being used to test overall achievement on the programs.

MUSIC

TOPIC

The Vocabulary of Music

OBJECTIVE

The primary objective of the music program is to provide students with a working vocabulary of musical terms.

UNIT DEVELOPMENT

Originally the music team hoped to use the I/71 audio system to teach rhythm and music notation. However, the delays in the development of the audio system caused the postponement of this curriculum development.

Therefore, the team chose to write an introductory program for either a musical literature class or a performance class. Basically the program is designed to insure that students acquire the necessary vocabulary to understand the classroom music instruction. The program not only provides an efficient means of teaching this vocabulary, but through teacher reports, should serve as a guide to indicate to the instructor concepts in which additional instruction in the classroom may be needed.

Eight units have been written:

1. Basic Rhythms.
2. Melody in Bass and Treble Clef.
3. Voice Classification.
4. Classical and Popular Vocal Style.
5. The Musical Show.
6. Tempo.

7. Form in Music

8. Musical Instruments

Several of these units are augmented by the I-70 Visual Display Unit. A teachers' manual has also been developed.

EVALUATION

These have all been used in paper and pencil format. Further evaluation will take place following an on-line run.

READING

TOPIC SELECTION

Supplemental Reading Instruction in Word Attack Skills

Phonic Analysis

Structural Analysis

OBJECTIVES

Students will master the phonetic skill necessary to attack words independently and have sufficient adeptness in structural analysis to read with ease and comprehension.

AUDIENCE

Students reading at a typical third grade level, both children and adults.

UNIT DEVELOPMENT

Scope and sequence charts from approximately twenty-five basal readers, phonic and spelling workbooks were examined. From these was derived a list of skills that are taught at third and fourth grade levels. These were then divided into phonic analysis and structural analysis. The skills were further divided into units which vary in size from four to ten lessons.

The program is designed to be used wholly or in part at the discretion of the teacher.

DEVELOPMENTAL TESTING

Pre and posttests are written for each unit. Selected units were tested on the teletype.

OTHER

The team originally focused on a developmental reading program but decided to delay such an approach until computerized audio was available.

BASIC READING SKILLS--SCOPE AND SEQUENCE

Structural

irregular plurals such as "children"

finding root words

"es" forms of nouns and verbs

"er" and "est" forms

changing "y" to "i" in verbs

structural endings of "en", "s", "ed" and "ing"

plurals with "s", "es" and "y" words

doubling final consonants

"ed" and "ing" endings on root words

methods of dividing words into syllables

prefixes--"a", "be", "un", "re", "dis", "in", "im", "ex", "pre", "pro" and "de"

suffixes--"ful", "less", "y", "ly", "er", "or", "ish", "ment", "able", "ous", "er" and "est"

recognizing syllables

affixes

compound words

synonyms

antonyms

homonyms

contractions

possessives

abbreviations

accents

Phonetic

initial, medial and final consonants

initial, medial and final consonant blends

initial, medial and final consonant digraphs

variable sounds of consonants such as "c" and "g"

make use of consonant substitution to form new words

silent consonants in words

long and short vowel sounds

vowel digraphs

vowel diphthongs

"r" influenced vowels

schioa sound of vowels in unaccented syllables

determining vowel sounds by position

variant spellings of vowel sounds

silent "e" rule

sound of "a" when followed by "l" and "w"

special sounds of "ci", "si" and "ti"

words ending in "le"

rhyming elements

irregular vowel sounds

three sounds of "ed" ending

diacritical markings

four sounds of "s"

"dge" ending

Comprehension

apply new ideas

follow sequence of events or ideas

draw conclusions

see relationships

predict outcomes

follow directions

read for definite purpose

find proof

SCIENCE

TOPICS

Mineral Identification

- Igneous Rocks
- Sedimentary Rocks
- Metamorphic Rocks
- Genesis of the Earth

Ecology

- Producers and Consumers
- Plant and Animal Adaptations
- Population Dynamics

OBJECTIVES

The scientific process of observation, hypothesizing, theorizing and catagorizing are emphasized. Behavioral objectives have been written for each lesson.

AUDIENCE

The program is specifically designed for 6th grade but may be used by any group which has attained a 4.5 grade reading level.

UNIT DEVELOPMENT

Actual mineral sample kits are a unique feature of the science program. The student works through mineral identification problems according to directions given in the teletype-presented instruction using the samples of minerals and chemicals provided in the kits. Other instructional aids utilized in the programs are slides projected by the I-71 Visual Display Unit and manual flip charts. A detailed teachers' manual developed by the team suggests additional classroom activities and experiments to supplement the CAI instruction.

The two programs, Ecology and Mineral Identification, are independent of one another. The first units of the Mineral Identification program also may be used independently, though the fourth unit requires the successful completion of the first three. The first two units of the Ecology program are independent, but are prerequisites to the third unit. There are a total of fifty-six lessons in the two programs plus pre and posttests for each of the seven units.

DEVELOPMENTAL TESTING AND EVALUATION

The Mineral Identification program was entered on the I/70 system, tested and revised. Both programs will be tested, revised and evaluated on the I/71 system.

SOCIAL STUDIES

TOPIC

The team agrees with current thinking in education which redefines the goals of social science instruction. A collection of facts about today and yesterday is no longer an acceptable objective. Students must be given the tools which will enable them to understand and function effectively in the rapidly changing social milieu. This approach to social science teaching may be called problem-solving, the process approach.

Specific objectives for each of the thirty-five lessons have been written.

UNIT DEVELOPMENT

The team has developed an extensive program of thirty-five lessons divided into six units in the categories of Defining the Problem, Information, Developing Hypotheses and Testing Hypotheses. These are followed by five gaming problems in which the student is required to solve the given problem using the techniques he has learned.

Designed for a 9th grade audience, the program could be used independently, but the authors feel that it would be more effectively used in conjunction with other classroom activities. A complete teachers' manual suggesting supplementary classroom work has been written by the team.

EVALUATION

The units have been used in a paper and pencil format. Lesson revision and some unit reorganization has been done as a result of classroom trials of printed lessons. Further evaluation and revision will occur following the pilot I-71 on-line run.

TOPIC

Spelling Rules

UNIT DEVELOPMENT

The INDICOM Spelling program was the first to make extensive use of the I/71 audio system. Designed for an audience which has attained a third grade reading level, the program is constructed as a modified strands approach to teaching spelling rules and generalizations. A diagnostic pretest identifies those generalizations in which the student requires instruction and drill.

Five hundred words are recorded on the audio disk of the INDICOM Project's RCA I/71 Computer System. Each of these words is keyed to the applicable spelling generalizations stored in the computer memory bank. The computer is programed to scan the audio vocabulary and terminal word list to generate random lists of appropriate words for the spelling drills at the end of each lesson. The drills are programed to provide massed and distributive practice as the student progresses through a unit.

The instruction (as opposed to the drills) is presented via teletype student terminals. Each unit is designed as self-contained, tutorial instruction. The spelling rules are explained and the student is asked to apply the rules to a number of examples. He may also be required to apply the rules to nonsense words and to discriminate correct from incorrect spelling. Each unit contains two to four lessons plus reviews and spelling games.

The program is presently a prototype which will be expanded. The first units teach those generalizations which research indicates cause the greatest number of spelling errors. The eight completed units deal with the following:

1. Syllables
2. "ing" endings
3. Plurals
4. Possessives

5. Hyphenated words
6. Abbreviations
7. Contractions
8. Compound words

EVALUATION

Evaluation will occur during 1971.

SUMMARY OF THE ACTIVITIES AND FINDINGS OF THE INDICOM PROJECT

1967-1970

Prepared By:

Dr. John Pagen
Superintendent, Waterford Schools
(Director, INDICOM Project, 1967-1969)

Mr. Ron Arnold
Director, INDICOM Project

In 1967, Superintendent of Waterford Schools, the late Dr. Don O. Tatroe, and the Secondary Coordinator, Mr. Roy Alexander, conceived a plan to use computer technology to improve the instructional offerings to students in the district. Waterford at that time had had several years experience with the district Data Processing Center that was used during school hours for instruction in the computer sciences and problem solving applications and in the evenings for administrative applications. The question posed was, "Could the computer be used to directly assist in the instructional process?" Some three years later and after thorough analysis of evaluation data, we can state with confidence that the computer is a viable medium for the instruction of youngsters, particularly in the basic skills area.

In CAI the computer is employed primarily to develop imaginative and innovative methods of teaching students. The speed and storage capability of the computer make it ideal for individualized instruction. There is immediate attention to the response of the students. The student is placed at the level of difficulty sufficient to challenge him, but not so difficult that it frustrates him. The program is designed so that the youngster finds success (a rule of thumb is that 90% of the students should succeed on 90% of the items). The computer responds patiently to the input of the student and is not concerned with family background, color, physical appearance nor his disposition to school - but rather to the response he makes to the educational problem. The interaction between student and machine is a very

personal relationship. (It is interesting to note that we've not had a single case of student vandalism on any of the 32 terminals in over two years of operation and over 300,000 student contacts.) There is little doubt that carefully designed CAI improves student performance and attitude toward school, subject matter and achievement.

INDICOM AND ACCOUNTABILITY

The acronym INDICOM equates to individualized communication. This is the essence of the teaching-learning dilemma. How can we communicate with the individual youngster? Accountability for individual student progress is the essence of the evaluation of the project. We define accountability as including these elements:

- the ability to diagnose youngsters' readiness for a given learning activity and to determine if the student really needs the instruction;

- the ability to prescribe instruction to meet the needs reflected in the diagnostic instruments;

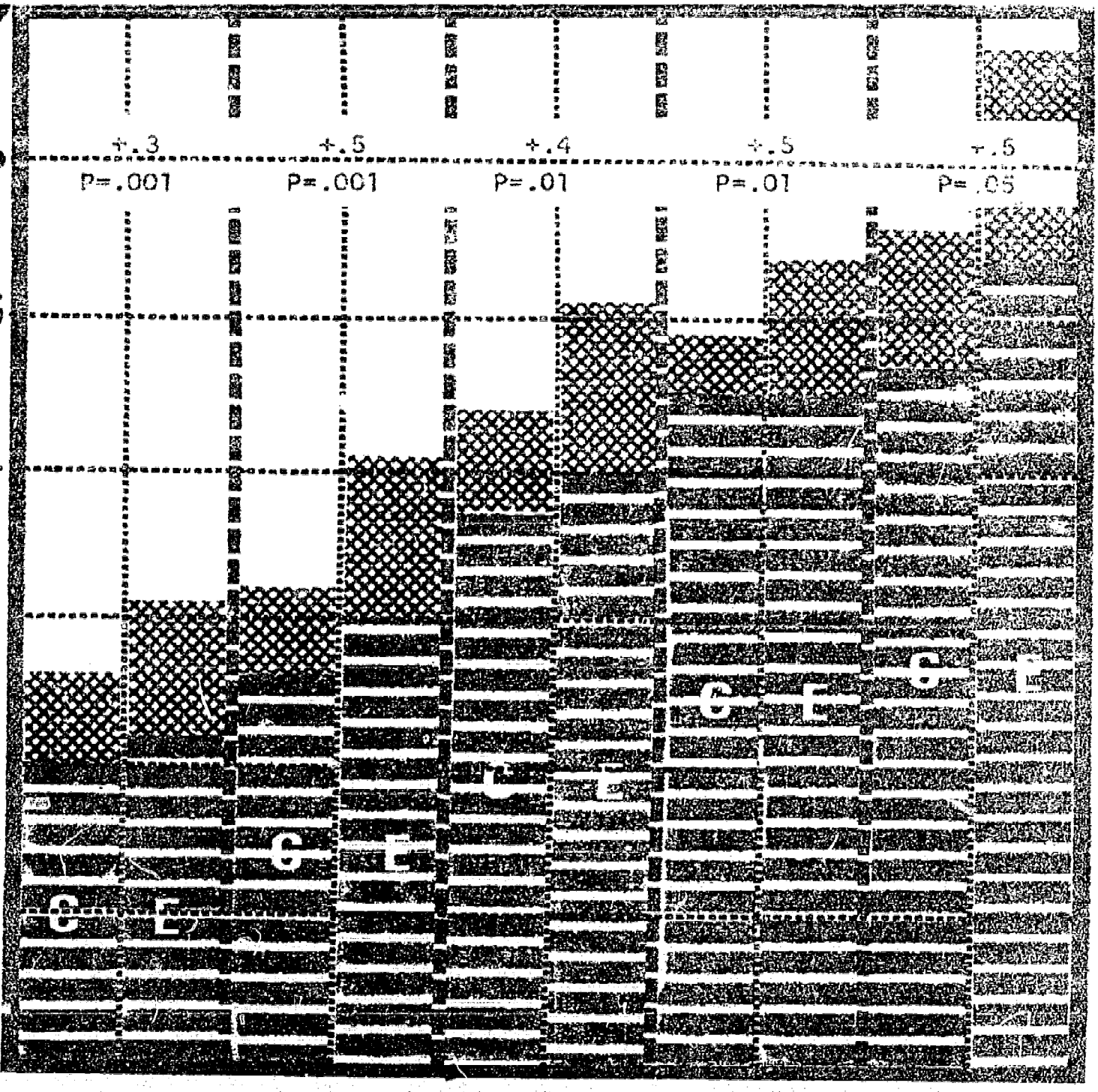
- and a continuous process of evaluation to determine subsequent needs and the effect of the instruction. The computer is uniquely equipped to store large amounts of data on students, curriculum, and evaluation, and to make decisions on this data based upon pre-designed programs.

We believe an accountability audit is mandatory for a project of this size and we commend your interest in our accomplishments.

A Review of Objectives, Accomplishments, Problems, Funding, et al ---

The following pages are devoted to reviewing the objectives and accomplishments of the INDICOM Project as well as noting the problems that have been encountered in this major project relating both to instruction and to inadequacies in federal funding.

SAT MATHEMATICS TEST RESULTS
GRADES 2-6
1969-1970



Grade 2 Grade 3 Grade 4 Grade 5 Grade 6

OBJECTIVES AND ACCOMPLISHMENTS

The general objective of the INDICOM Project was to improve instructional offerings for youngsters by employing computer technology. Specific objectives include the definition of curriculum goals in specific behavioral terms; the establishment of efficient and effective training programs for district personnel; the investigation of the growth made by participating students; the investigation of whether or not computers do, in fact, assist the teachers and relieve them of routine tasks to conduct more creative activities; to point the direction towards defining the role of students and teachers in a program of computer assisted instruction; and to develop an effective dissemination program for the INDICOM Project. External and internal evaluations would indicate that the project has been an overwhelming success in meeting these objectives.

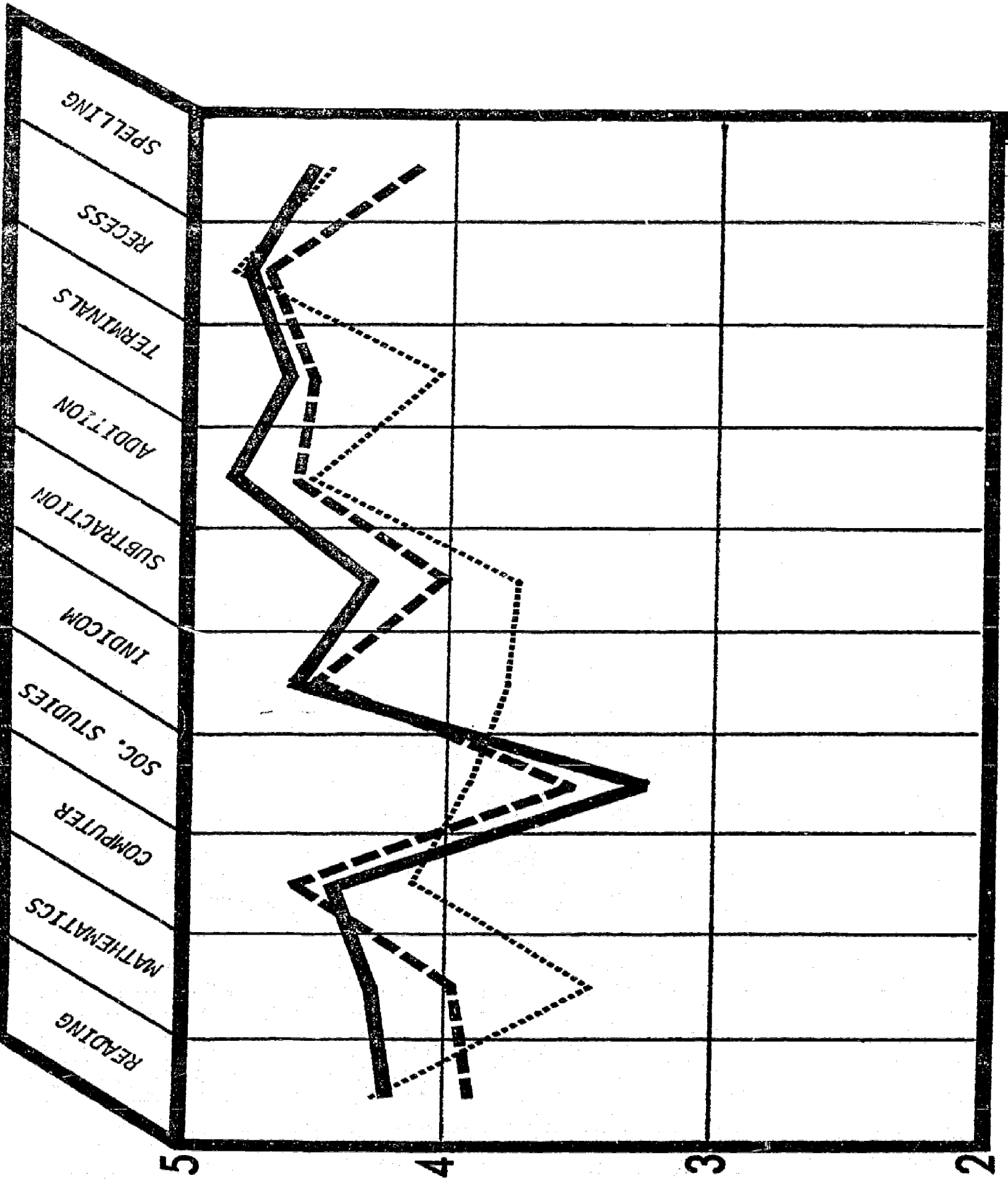
There are numerous reference documents available that detail the statistical analysis of the measures of achievement in the project.

In summary, INDICOM, over the last two years, has demonstrated the following:

- the ability to manage a major innovative project through conception to implementation - reporting evaluation data fairly and accurately;

- achievement in mathematics and language arts can be extended and accelerated by CAI. This fact has been documented by testing in the elementary and high school levels. The summary of the math evaluation data clearly shows significant gains at all levels. (Incidentally, the recent State Assessment data corroborates the findings of the elementary program). You will note in the SAT Mathematics Chart that each grade level had significant differences in favor of the CAI (experimental) group beyond $P = .05$. It should be noted that all Waterford elementary youngsters were on reduced schedules during 1969-1970.

- student attitudes towards mathematics and language arts improves when CAI is utilized (State Assessment data supports this finding, also). See Attitude Survey Chart.


READING
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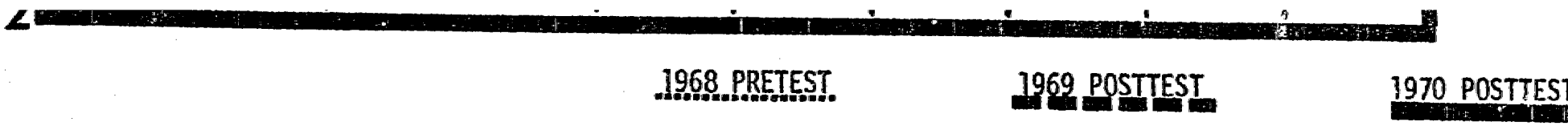

1968 PRETEST
1969 POSTTEST
1970 POSTTEST

- preliminary analysis of data indicates statistically significant gains in all mathematics areas treated by CAI for Senior High School underachievers and low achievers.

- a small pilot study with eight adult basic education students showed a gain in mathematics achievement of three years (average) in ten 1 1/2 hour sessions.

- students continuing interest in CAI indicates that the improved performance is due primarily to the personalization of instruction, that is afforded through CAI rather than the initial impetus provided by the hardware. While it is still too early to completely write off the possibilities of the Hawthorne effect, we find no indication of waning interest on the part of students.

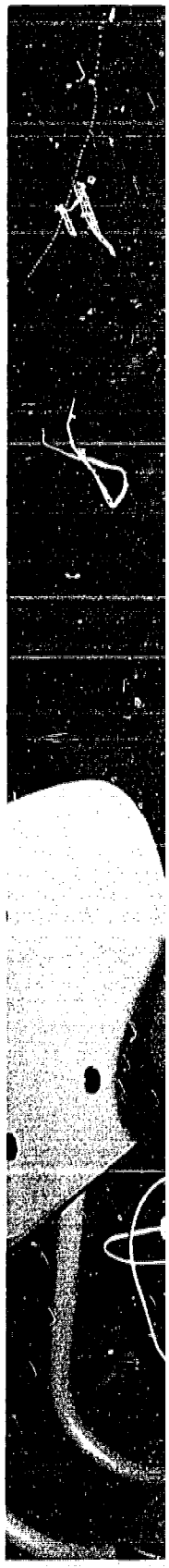
- teachers who apply the logic of the systems approach to CAI design appear to exhibit a more positive attitude toward teaching and learning in general; that is teachers are more inclined to view teaching and learning in a cause and effect relationship which, again, is the essence of accountability;

- the development of CAI at this point in time is a demanding and costly process that requires funding beyond the normal budget of any school district;

- there is sufficient subjective data to indicate that CAI is particularly appropriate for youngsters classified as handicapped learners, specifically the deaf and mentally retarded. We have a major proposal submitted to the U. S. Office of Education (and reviewed by State Department officials dedicated to formal work with this audience).

- the curriculum design work in the project has had significant impact upon the school district as a whole. The employment of the systems approach to curriculum development and the use of sophisticated management techniques such as PERT have been widely disseminated in the district to the ultimate benefit of all students in the school system.

In summary, there is little doubt that the significant gain data in the experimental groups can be attributed to the uniqueness of the approach afforded through computer assisted instruction.



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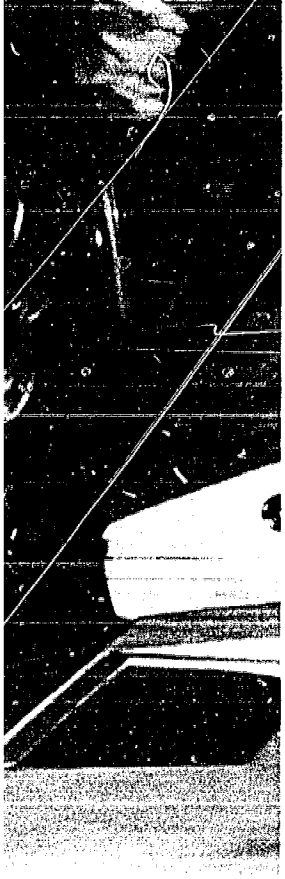

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Dr. John Pagen
Superintendent Waterford Sch
(INDICOM Project Director

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A project of this magnitude and this importance presents a major challenge to a district of this size. Very few of us in our lifetime really have an opportunity to work with a program that we believe will really change the destiny and the structure of American education. We have welcomed and have urged external evaluation of the effectiveness of this staff in accomplishing our charge. Don Goodson, Coordinator of ESEA Title III, his staff, and appointed evaluators have been primarily charged with this responsibility. From all feedback that we have received, both formally and informally, I believe we can state with confidence that they consider the project operation to be extraordinarily sound.

> This unique and highly sophisticated computer assisted instruction project is aimed at individualizing the instruction of elementary and secondary school youngsters through pioneering in sometimes unknown areas of computer technology. Local teachers write computer programs in the areas of math, science, business, humanities, industrial arts, language arts and reading, social studies, guidance, and classroom management. The implications of INDICOM are great for future education in Michigan and the nation. Disregarding the CAI aspect of this program, the project could still serve as a model for other school districts of thorough and sound curriculum development with widespread teacher involvement and well planned evaluation techniques. *

Project operations for the past three years can be summarized as follows:

Year 1 was primarily committed to the planning of project activities, recruitment and selection of staff, training of personnel, negotiations with and selection of the vendor and development of evaluation documents.

Year 2 we moved to an operational stage on RCA's computer system in Palo Alto, California; we continued curriculum preparation; a massive dissemination program was begun; we continued our training efforts and further developed our evaluation activities.

* Miller, Peggy, "Waterford Public Schools - INDICOM (Individual) Communications System" MASB Journal - December, 1969.

Year 3 has been characterized by the transition to the on-site computer system (RCA 1/71) with all the normal installation problems and the field-testing and revision of curriculum; major evaluation activities have been completed; dissemination efforts have been highlighted by on-site visitations, a National Conference co-hosted with the State Department of Education and numerous other techniques such as periodic newsletters, slide tape presentations and the like.

Based upon the soundness of the evaluation data, project continuation is our primary focus at this time.

In this section on Objectives and Accomplishments we have summarized the data from the INDICOM Project. A question could be raised as to whether CAI would be as appropriate for a student population that was quite different from that in Waterford, specifically, the inner-city black, Spanish American, and rural student. The New York City CAI Project worked primarily with inner-city black and Puerto Rican students. The McComb, Mississippi CAI student population was primarily rural black and white students. Both of these projects reported dramatic gains in achievement by the CAI groups in 1968-69 when compared to non-CAI instructional groups. These two projects used the same mathematics curriculum as INDICOM during the 1968-69 school year and their findings would support our conclusion that computer assisted instruction in mathematics does significantly improve youngsters' performance.

PROBLEMS AND SERENDIPITY

In a major innovative project it is just as important to report the problems as the promise. All too often people forget that negative findings, honestly reported, are as important as positive findings. The most significant problem was our inability to accurately assess the magnitude of the task that we had undertaken. This was true also of the hardware supplier, RCA. Although the 1/71 system is completely installed, the system is not performing to expectations, particularly the audio and graphic enhancements. Some difficulty must be expected as these two enhancements are right on the cutting edge of instructional technology. There are few references for comparison, so problems must be expected. However, some of the problems we're now having are beyond the range of normal expectancy and we intend to hold RCA to the contractual commitments.

We have every reason to believe that RCA will maintain its commitment until the 1/71 System is a viable system.

Severe problems have resulted from spiraling costs and inadequacies in federal funding. Appropriations have never equalled the funding

and we were asked to make reductions in programs at the least opportune time. For instance, in the third year of the project, our full-time staff was reduced by 30%, design team activities reduced by 75% and in-service training of our other staff almost totally eliminated.

The development of computer assisted instruction seems to crystalize all that we don't know about teaching and learning! Several programs that were developed simply did not work. In science, for instance, we developed elaborate branching techniques that confused rather than directed students. We've been guilty of underestimating the student consistently in terms of what he is able to do when presented materials at the appropriate level with a high probability of success. We have discovered whole new problems in terms of copyright and costing of instructional materials. (How does a publisher price CAI materials? On one disc an entire curriculum could be stored for use by any school district anywhere in the country provided it had access to the I/71 System.) How do we protect the confidentiality of student performance and historical data and still provide it in a meaningful format to classroom teachers? We discovered that providing the teacher too much data may be a problem; reports with too much detail on student progress tend to be confusing rather than enlightening to the teacher.

There are a host of unresolved problems in the use of computer technology in instruction. But problems always accompany significant change. We need to know more about how students learn, how most efficiently to use teacher time and how to program effectively for true individualization of instruction. Research at Florida State University indicates that individualized instruction itself is more appropriate to the youngster with certain personality characteristics. These problems need further research.

- Students (especially the handicapped) typically performed at a higher level than was expected and exhibited few problems with the operation of the terminals;

- the student proctors provided invaluable aid in the preparation and loading of CAI, the monitoring of students, and the handling of visitors - while at the same time developing sophisticated skills in the computer science;

- eleven year old students have written, coded and loaded their own spelling curricula using the SIMPLE Language;

- the project served as a catalyst for advanced studies. Over 1/2 of the full time staff and many of the design team staff received advanced degrees over the last three years. Several doctoral dissertations have been written or are in the process of being completed around project data.

- elementary students can actually enjoy academic summer schools (in addition to showing achievement gain.)

- not the least of the benefits for Waterford and the State of Michigan has been the visibility provided the district and the state. Several thousand visitors have examined the INDICOM facilities from most of the fifty states, Canada, and many foreign countries.

DISSEMINATION

Dissemination is a very necessary and a very costly function of a project of this nature. We've had over 2,000 visitors to the Mott CAI Lab alone since February 1, 1970. We have been committed from the beginning that our public relations would not exceed our progress. We found this to be the case in many visitations we made early in the project. However, in terms of "grantsmanship," honesty is sometimes a handicap. The July, 1970 National Conference in Computer Applications to Learning sponsored by INDICOM and the State Department of Education was designed to be the culminating dissemination activity of the three year project.

The evaluation of the conference indicated it was a tremendous success. INDICOM'S prominence in National conventions and even in International meetings indicates the regard the educational and computer community holds for the worth of project activities.

FUNDING OF PROJECT ACTIVITIES

The 1960's have been characterized by the application of computer technology to effect better accounting practices in education, to train youngsters in the computer sciences, and to instruct youngsters in the use of a problem-solving tool. The 70's, from all evidence, will be characterized by the use of the computers to directly assist us in the instructional process.

If we really believe that we must find ways to educate all youngsters, then we must recognize the tremendous problems concomitant with that goal. Instruction becomes increasingly complex as more youngsters stay in school for longer periods of time. It is estimated, now, that the amount of knowledge available in this society doubles every ten years. The cost question may ultimately be, "Can we afford to do any less than provide the personalized instruction that is available through the use of the computer in instruction?"

The immediate financial operation problem facing INDICOM is securing adequate funding for continued research and development activities. We have proposed that the State Department of Education and State Board of Education support project activities by:

(1) meeting the financial obligation to RCA, contingent upon satisfactory performance of the system, of $153,650.00 out of ESEA Title III funds. (The Michigan Board of Education and Department of Education have provided these funds through a supplementary ESEA III grant);

(2) supporting continuing operations in the district through either direct allocation or through consideration under categorical funding. The continuing costs for the project range from a minimum of $70,000 for operation per year to a maximum $400,000 a year for regional center:

(3) continuing to support the school district in the solicitation of funds from Federal and private sources for research and development in instruction. The project has demonstrated the benefit of CAI to youngsters and current projections indicate that hardware costs will greatly diminish in the next decade.

Michigan is in a position to maintain its leadership role in this area by careful planning and investing at this time.

The curricula and software developed in Waterford should be of great interest to other school districts as they move toward CAI. Many school districts have inquired as to the availability of INDICOM lessons for their use. As the material was produced in the public domain, it would be available to other users. On-site computer systems are becoming more common. As this trend continues and accelerates, more and more school districts will begin to look at computer technology for direct assistance in the instructional process. It is critical to the taxpayers that the future CAI developments in this State use the accomplishments and failures of the INDICOM Project as a point of departure. Costly duplication of effort cannot be tolerated in the development of computer based instructional systems as the initial costs will be very substantial.

The Waterford School District Board of Education stands ready to support the project within the limited resources of the school district. Waterford has one of the highest operating levies (30.63) in the State. Even with this substantial effort it will be difficult to restore youngsters to full programs. Three years ago it would have been very difficult to predict the soaring salary schedules and the emergence of powerful employee bargaining units. The full support for the INDICOM Project would be simply beyond the ability of the district. Continuing discussions are taking place with RCA concerning their corporate commitment to CAI and to Waterford in particular. RCA has invested millions of dollars in CAI development and can't be expected to assume 90% of maintenance costs

indefinitely. We propose that the full value can be extracted from the project through a cooperative tripartite funding arrangement of Waterford, public funding sources, and RCA. The ultimate objective would be to have the I/71 System an affordable instructional medium for this school district and others.

The hard data available from the project, external evaluators and State Assessment demonstrates that CAI can improve youngsters' achievement in the basic skills areas; in addition, the CAI student manifests a more positive attitude toward school.

Indications are that hardware costs will go down in the seventies and that widespread application of CAI will be a reality.

Dr. Patrick Suppes of Stanford University observed that " . . . it is of the greatest importance to emphasize that the existence of the technology and the recognition of its possibilities are not in themselves sufficient to guarantee that it will be used wisely or that it will be used with anything like maximum efficiency. From the standpoint of educational theory and practice, the deep and complicated problems begin only when it is recognized that the technology is ready for application and that we need to understand how it should be used." * The State has much to gain by insuring the perpetuation of instructional related computer activities in Waterford until full value has been extracted.

In conclusion, we respectfully acknowledge the cooperation and encouragement we have received from the State Department of Education - particularly the ESEA Title III offices under the direction of the late Don Goodson.

* Suppes, Patrick; Jerman, Max; and Brian, Dow; Computer-Assisted Instruction; Stanford's 1965-66 Arithmetic Program, Academic Press, New York, 1968, p 2.

GLOSSARY

Access Time

The time it takes the computer to locate data in its storage section and transfer it to the arithmetic unit, where the required computations take place; also, the time it takes to transfer information which has been operated on from the arithmetic unit to the location in storage where the information is to be stored.

Author

One who designs and writes a course for computer-based instruction.

Bit

An abbreviation of binary digit; the smallest unit of information in the computer, being dual-state (on or off, one or zero).

Byte

A group of adjacent binary digits usually operated upon as a unit, and shorter than a word. In the Spectra 70/45, a byte contains eight bits.

Cathode Ray Tube

An electronic vacuum tube containing a screen on which information may be stored or displayed.

Central Processing Unit

The portion of the computer containing the arithmetic, control, and main storage units.

Code

A system of symbols for representing data or instructions in a computer.

Command

The portion of an instruction which specifies the operation to be performed.

Computer

A device capable of accepting information, applying prescribed processes to the information, and supplying the results of these processes; usually consists of input and output devices, storage, arithmetic, and control units.

Computer-Based Instruction (CBI)

Instructional method using a computer system for presentation of materials, evaluation of response, scoring and grading, and other functions.

Concept Block

A set of data base materials covering a specific concept within a course. In the Mathematic Drill and Practice program published by L. W. Singer, a concept block includes a pretest, posttest, and five days of drill and review.

Configuration

A group of machines which are interconnected and are programed to operate as a system.

Course

A set of instructional materials covering a specific subject (e.g., mathematics, reading).

CRT

(See Cathode Ray Tube)

Curriculum Data Base

Lesson materials stored on magnetic disc and available as needed by the procedure program. Contains questions, answers, tutorial text, control information, and any other data needed during course presentation.

Data

Basic elements of information (facts, numbers, letters, or symbols) which can be processed or produced by a computer.

Data Set

A device used to convert data signals to and from other signals which can be transmitted; used to permit data communication over telephone channels.

Data Translator

A program for translation of specially coded curriculum materials, into a specialized format which can be used by a procedure program.

File

An organized collection of information directed toward some purpose and treated as a unit. In CBI, a curriculum file usually represents all or part of the subject matter information needed for a particular lesson.

File Maintenance

The periodic modification of a file to incorporate changes which occurred during a given period.

Flow Chart

A graphic representation of the major steps in a program or a system of programs. Symbols are used to represent operations, data, flow, and equipment.

Hardware

The physical equipment or devices forming a computer and its peripheral equipment. Contrasted with software.

Input

Information or data transferred from an external storage medium into the internal storage of the computer. Also describes the routines which direct input, or the devices from which such information is available to the computer.

Input Device

The mechanical unit designed to bring data into the computer, e.g., a card reader, tape reader, keyboard.

Language

A system for communicating information between people, or between people and machines. Such a system consists of a carefully defined set of characters, rules for combining them into larger units such as words and expressions, and rules of word arrangement to achieve specific meanings.

Line Concentrator

A small computer used in the CBI system for directing and controlling the flow of information between the control computer and instructional terminals. Also performs other miscellaneous functions, e.g., issuing standard messages to terminals.

Load

To place data into internal storage.

Magnetic Disc

A storage device on which information is recorded on the magnetized surface of a rotating disc. A magnetic disc storage system is an array of such devices, with associated reading and writing heads mounted on movable arms.

Magnetic Tape

A storage device in which data is stored in the form of magnetic spots on coated plastic tape. Binary data are stored as small magnetized spots arranged in column form across the width of the tape; a read-write head is associated with each row of spots.

Main Storage

Usually the fastest storage unit of a computer and the one from which instructions are executed. Contrasted with auxiliary storage (e.g., magnetic disc, magnetic tape).

Mass Storage (on-line)

The storage of a large amount of data which is also readily accessible to the central processing unit of a computer. An example is the mass storage of curriculum on magnetic disc.

Message

A definite sequence of letters, digits, symbols, etc. Especially sequences of characters displayed at the instructional terminal.

Microsecond

One millionth of a second, abbreviated Microsec.

Millisecond

One thousandth of a second, abbreviated Msec. or Ms.

Multiplexing

The interleaved or simultaneous transmission of two or more messages for a single channel; the process of transferring data from several storage devices operating at relatively low transfer rate, in such a manner that the high-speed device is not obligated to wait for the low-speed devices.

Nanosecond

One thousandth of a millionth (i.e., a billionth) of a second.

Off-Line

Pertains to equipment or devices not in direct communication with the central processing unit of the computer; also used in CBI to refer to processing done during non-CBI hours, i.e., when students are not communicating with the system from terminals.

On-Line

Pertains to equipment or devices directly connected to the central processing unit; also used in CBI to refer to CBI hours, when students and teachers can communicate with the system through terminals.

Output

The information transferred from the internal storage of a computer to an external device; used to refer to the routines which direct the output, and the device or set of devices necessary for output.

Parameter

A variable that is given a constant value for a specific purpose or process.

Performance Record

A record on magnetic disc, in the Student History Vector file, containing performance information on a student registered in a CBI course.

Peripheral Equipment

The auxiliary machines which may be placed under the control of the central computer, e.g., card readers and punches, magnetic tape feeds, high-speed printers.

Printer (line)

A device capable of printing one line of characters across a page simultaneously as continuous paper advances line by line in one direction past type bars or a type cylinder that contains all characters in all positions.

Procedure Program

A computer program written in ISL-1 by the course author or programer detailing the steps to be followed by the computer during CBI processing.

Program

The complete plan for the solution of a problem, including data gathering, processing, and reporting; more specifically, the complete sequence of instructions and routines necessary to solve a problem. To plan the procedures for solving a problem.

Random Access

(1) Pertaining to the process of obtaining information from or placing information into storage, where the time required for such access is independent of the location of the information most recently obtained or placed in storage; (2) pertaining to a device in which random access can be achieved without effective penalty in time.

Read

To transfer information from an input device to internal or auxiliary storage; to sense information contained in some source.

Response Time

The elapsed time between generation of an inquiry at a terminal and receipt of a response by the system.

Software

The totality of programs and routines used to extend the capabilities of computers, e.g., compilers, assemblers, executive routines, etc.

Source Language

The original form in which a program is prepared prior to processing by the machine. Instructional Language-1 is the source language used for procedure programs in the CBI system.

Source Program

A computer program written in a language designed for ease of expression of a class of problems or procedures, e.g., symbolic or algebraic.

Statement

A meaningful expression or generalized instruction in a source language.

Storage Capacity

The number of elementary pieces of data (e.g., characters of bytes) that can be contained in a storage device.

Store

To transfer an element of information to a device from which the unaltered information can be obtained at a later time; to retain data in a device from which it can be obtained at a later date.

Student History Vector

A CBI record reflecting a student's daily progress in the course. The Student History Vector file is maintained and updated through both procedure program processing and off-line processing.

Syntax

The rules governing sentence structure in a language, or statement structure in a language such as that used for a compiler.

System

A group of procedures, processes, methods, routines, or techniques related by some form of regulated interaction to form an organized whole.

Teletype

A typewriter like device used as input/output to student.

Terminal

A device in a communication network capable of sending and/or receiving information over a communications channel.

Time Out

A condition which occurs when a student fails to complete a response in the time allotted by the course author.

Time-Sharing

The use of a device for two or more purposes during the same overall time interval, accomplished by interspersing component activities in time.

Tutorial

Pertains to functions exercised by a tutor, i.e., instruction to an individual or a small group of students. In CBI, the tutorial mode involves instruction rather than testing, and is contrasted with drill and practice.

Update

To make changes in a file required by correct information or transactions.

Word

An ordered set of characters occupying one storage location and treated by the computer circuits as a unit.