ASSESSMENT OF TECHNOLOGY-BASED SUPPLEMENTARY INSTRUCTION FOR STUDENTS GRADES 7-8

A Research Report

IMPAC®

Instructional Microcomputer Project for Arkansas Classroms

ARKANSAS DEPARTMENT

OF

EDUCATION

AFFECTING GRADES 7-8 BASIC SKILLS ACHIEVEMENT THROUGH TECHNOLOGY

AN IMPAC RESEARCH REPORT

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Instructional Microcomputer
Project for
Arkansas Classrooms

Prepared by the
Arkansas Commission on Microcomputer Instruction
Department of Education
Little Rock, AR 72201

December 30, 1987

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Introduction

Purpose of the Study

This is a report on the research and development activities that relate to the 1985-87 Instructional Microcomputer Project for Arkansas Classrooms (IMPAC) programs in junior high schools. This report is the second in a series of three reports evaluating the IMPAC supplementary basic skills learning system that now affects 136 school districts in Arkansas. The first report, AFFECTING BASIC SKILLS ACHIEVEMENT THROUGH TECHNOLOGY - A Research Report, was published December 15, 1985, and distributed to all fifty state departments of education and numerous researchers in the United States and several foreign countries. The third research report on IMPAC will include findings on over 30,000 students and 1,000 teachers in grades 4-6. The report will include an analysis of maintenance cost and educational and cost effectiveness studies. The report should be completed by June 30, 1988.

Role of Research in IMPAC

The application of statistical and mathematical techniques to aid in the administrative decision making process is referred to as systems analysis. Although quantitative analytical techniques do not furnish all the necessary information for decision making, they are of substantial help. Research in IMPAC is designed to provide a tool for decision making to maximize the return on educational dollars spent on using technology to enhance learning in high priority areas.

Data bases designed to interact with statistical and applied mathematics forecasting programs provide continuous monitoring of programs so that the effect of improvements on educational programs can be considered and current and alternative program cost compared. The most feasible and acceptable means for accomplishing a given purpose usually results from analysis of data tempered with a knowledge of the human resources available, local educational priorities and the public being served.

The application of systems analysis to IMPAC projects will continue to require communications between experimental sites, the monitoring of projects on a year to year basis and a staff that can help teachers respond to changes in the variables that affect learning. Since controls may need to be imposed, a good working relationship between administrators and teachers has been established. Such cooperation will be enhanced if IMPAC can provide guidelines for action and promised results are clearly visible and justify the means.

Technologists are creating efficient and effective learning tools through the use of minicomputers, microcomputers and interactive videos. The key to instructional integration of these tools is to successfully combine them into interpersonal, peer group interaction and cognitive problem solving activities thus enhancing retention and encouraging an interest in more learning. The degree of success of computer enhanced collaborative learning is a function of time on task, peer group/teacher-principal reinforcement, realistic student goals and the efficient targeting of objectives followed by direct CAI instruction.

The IMPAC staff is motivated to work with teachers and principals in developing a positive reinforcing classroom atmosphere. This human endeavor is enhanced by the Program for Effective Teaching (PET) and the Classroom Management Program currently in use in most Arkansas classrooms. Technology, from the IMPAC perspective, provides instructional tools to be used under the direct control of the classroom teacher. The research in this report is consistent with the philosophy stated in this introduction.

Overview of IMPAC

Act 528, enacted during the 1983 Legislative session, established a nine-member commission to assist Arkansas public schools in utilizing microcomputers in basic skills instruction, grades 4-8. The Commission is providing leadership in the development, implementation and evaluation of a supplementary computer based basic skills learning system.

Since the fall of 1983, IMPAC has been testing and improving an instructional model that combines regular instruction and computer managed/computer assisted instruction (CMI/CAI). The teacher does regular basic skills instruction 80 percent of the time and uses CMI/CAI 20 percent of the time. Students in an IMPAC program work lessons on microcomputers networked to a hard disk drive, either in a lab with 26 stations supervised by their teacher and a lab manager, or in their regular classroom with 4-8 stations. The mathematics, reading, language arts and science lessons are correlated to the Arkansas Basic Skills Objectives list.

IMPAC Procedures and Services

School districts respond to applications sent out in the spring of each year. Out of 80-90 applicants, approximately 30 districts are tentatively chosen for an IMPAC project. Criteria for selection is well defined and is included in the application. An IMPAC administrator visits each school district and assists in determining the type of IMPAC project, the project site, and grade levels and teachers to be included. The program is then scheduled for implementation either in the fall or spring semester.

The hardware and software secured through IMPAC Learning Systems, Inc. is installed in facilities that meet IMPAC standards and electrical specifications. A two-day initial in-service workshop is conducted, and the program is operational immediately. Teachers are trained to review software, utilize correlations and objective/lesson lists, do preventive maintenance, make individual or group assignments and interpret reports generated by the computer on student performance.

IMPAC staff supervises each IMPAC program and maintains the hardware and software during its entire 5-7 year life.

Survey of Literature
Related to Basic Instruction

A survey of literature published since 1960 indicates that three types of research are relevant to the study: research that provides direction for improving instruction related to classroom and school level variables; research that is directly related to improving instruction in mathematics, reading and language arts in which traditional instructional methods were used; and research in which instructional improvements involved technology, particularly computers and computer-assisted and computer-managed instruction.

Classroom and School Level Variables

Significant findings related to classroom and school level variables have been reported by researchers over the last few years.[13] In the context of classroom and school variables, desirable components for an instructional system can be clearly identified and defined. These variables can be measured and described as being present or absent during an instructional time period.

The Program for Effective Teaching (PET), developed by Madeline Hunter, provides the basis for a teaching-learning model for teacher orientation.[21] The model incorporates concepts related to effective instruction, classroom management and established principles of learning theory. Appendix A is a matrix that indicates the relationship between PET classroom instructional practices and CMI/CAI.

Achievement in Mathematics

No general conclusion can be drawn from research regarding the relative efficiency of any one organizational pattern for mathematics instruction. Neither team teaching, departmentalization, self-contained classrooms, nor any other organizational pattern, per se, increases pupil achievement in mathematics. Higher achievement in computation, problem solving and mathematical concepts occurred regularly when about half of the class time was spent on developmental activities, with the remainder on individual practice.

Within self-contained classrooms the teaching strategy most often associated with high achievement incorporates flexible grouping, unit planning and diagnostic evaluation. Computers in the classroom may enhance this process through supplementary instruction coordinated with group activities.

Mathematics achievement is enhanced when children are placed at the appropriate skill development level, and their interest in learning is maintained through knowledge of success resulting from immediate feedback. Intensive practice and cumulative review should be provided regularly to reinforce skill development. Guided discovery lessons and problem-solving activities also enhance learning and should be infused into the curriculum on a regular basis.

Mathematics is viewed by a high percentage of students as the most useful subject with everyday applications. However, the precision of mathematics, sequentially developed concepts, lack of mastery of number facts and the ritual of algorithms are sources of discouragement for most students.[12]

Achievement In Reading and Language Arts

Research on methods of teaching reading and language arts is extensive, and in many cases, highly technical and related to general theories of learning and educational philosophies. There are, however, numerous studies related directly to the mechanics of teaching and characteristics of effective teachers as measured by student achievement.[14]

In general effective reading and language arts teachers:

1. Target basic skills and try to insure that students are actually trying to master them
2. Diagnose their students' needs and plan instruction on their findings
3. Explain directly to their students by definition and example
4. Provide varied and meaningful practice to insure mastery and transfer of basic skills
5. Use flexible grouping
6. Expect students to be successful in learning
7. Are good classroom managers
8. Encourage leisure reading in a nonthreatening environment

The specific method used in teaching reading is usually consistent with, or determined by, the textbook series adopted by the local school district. Supplementary instruction through pull-out or in-class programs is generally available through special education and Chapter I programs that target low achievers or students with special needs.

Problem Solving

Verbal analogies, inductive/deductive reasoning, logical reasoning, and problem analysis are the four factors usually studied in attempting to determine the effect of certain computer activities such as LOGO or real-world simulations on problem-solving ability. Specific problem-solving activities of one type do not seem to transfer to new, dissimilar situations. Experience with identification of a problem, brain storming, evaluating specific hypotheses, and interpreting results still provides learning equal to or better than that using computer technology.

In general, to solve a particular type of problem one must have a good knowledge base in areas related to the problem situation. The vocabulary and symbolic language required to explore and evaluate proposed solutions often come only after years of experience. Computer simulations may help students acquire these skills at an accelerated rate.[30]

Matching Basic Skills Standardized Test Objectives

Detailed studies indicate that conclusions drawn from research are often affected more by in appropriate evaluation instruments than by research design.[15] For example, the Stanford Achievement Test, Iowa Test of Basic Skills, Science Research Associates Tests, and Metropolitan Achievement Tests relate to specific skills, and the correlation with state or local objectives must be checked carefully to assure content validity. Item distribution by concept or skill as measured by the percentage of test items has high variability. Therefore, it is likely that there can be significant discrepancies between the content a teacher presents to students and the content being tested on the standardized test. This difference may result in an underestimation of student achievement.

The three criteria used in selecting test items for a norm-referenced test (NRT)--item discrimination, item difficulty, and item content--assure that an NRT results in mismatches between what is being tested and what is being taught. Items that test good objectives are often eliminated because of simplicity. Therefore, minimum competency testing and the numerous court cases related to bias and content validity have led to the pseudoscience of objective-based or criterion-referenced test construction and test item specifications that result in a high correlation between test results and student mastery of objectives.[15]

Analysis of Reviews of Research Studies on Computer Based Instruction

Relevant Conclusions

The purpose of this section is to review the analysis of eight summaries of research studies related to the use of Computer-Assisted Instruction (CAI) and Computer-Managed Instruction (CMI).

CMI applications require extensive training and involvement by participating teachers and principals. CMI programs especially developed to provide reports on the testing and monitoring of basic skills are moderate in cost, but time consuming to develop. Such programs do help teachers target specific objectives for review and remediation. One microcomputer system including an appropriate disk drive, monitor, printer and card reader or answer sheet scanner with associated CMI software can serve 12-40 teachers and be cost effective.

CAI applications can be managed through stand-alone computer systems without management, or networked computer systems with management in several classrooms or a laboratory. The number of students per microcomputer system, classroom organization (self-contained, semi-departmentalized, departmentalized), objectives included in the courseware, and time on task and classroom management procedures are some of the critical factors that determine the educational effectiveness of CAI instruction.

The relevant conclusions drawn from the reviews include:

1. Substantial savings (20 to 40 percent) in time can be achieved for learning as compared to "conventional" instruction.[8,6,30]
2. Retention following CAI compares well with retention following conventional instruction.[6,30,45]
3. CAI seems most effective for student achievement at the elementary level. Students in classes using supplementary CAI instruction generally performed at the 63rd percentile when compared to the control group which performed at the 50th percentile.[4]
4. Quality courseware that targets specific objectives should generally include the following features:
   a. Control of the program by the student, with adequate help features
   b. Feedback and rewards when appropriate
   c. Monitor students progress
   d. Easy operation
   e. Tutorial, simulation and drill and practice features with occasional game formats for some lessons[45]
5. The appropriate instructional time for CAI from a learner, administrative and classroom management standpoint is 12-20 minutes on task every other day in at most two subjects[30]
6. Achievement gains in reading and language arts are about 70% of the gains in mathematics when instruction is supplemented with basic skills CAI.[30]
7. The effective use of CMI for diagnosis and prescription of learning activities requires extensive teacher involvement in developing a generic management system into one that specifically meets local needs. Implementation of CMI systems has to be preceded by in-depth training on the part of all instructional staff, principals, and key administrators, particularly in the area of individualized instruction. CMI can be a vehicle for prescribing CAI for the remediation of objectives identified through the testing features of CMI. Progress in basic skills achievement can be monitored and reports generated using comprehensive CMI programs. However, the process is time consuming, and test items must be based on item specifications related to state basic skills tests.[30]
8. Computers in the classroom must be managed by the teacher and not support personnel. CAI and CMI extend the teacher's ability to assess student performance, target certain objectives for remediation and provide enrichment in problem solving activities. Flexible scheduling, good classroom management, comprehensive CAI packages, effective in-service training for teachers and good vendor support for hardware and software are important factors in the success of CAI supplementary instruction.[29]
9. Student attitudes toward CAI, highly positive in 1984-85, are expected to decline as home and school use of CAI increases at a faster rate than the quality of courseware increases.[30]
10. Most policy making officials within school districts are interested in using computers effectively through programs that increase or monitor student performance and increase teacher productivity. However, most of these officials are not aware of the conditions under which these programs are most likely to be successful.[31]

11. State and Federal policy makers are showing an increased concern for the effective use of technology in education and are seeking ways to avoid duplication of effort and waste.[43]

In a recent publication by Charles Blaschke[5], he indicates that while microcomputer-based CMI/CAI network configurations appear to enhance student achievement, their potential in reducing staff time has not been demonstrated. Network configurations were identified that accommodate generic instructional management systems which facilitate effective integration of courseware into curriculum areas.

With regard to advancing technologies, Blaschke concludes that there is a convergence of interactive video, telecommunications, and laser disc technology with microcomputers. The number of videodisc programs has increased dramatically. CD-ROM applications to CAI are increasing, but dramatic advancements with CD/I await industry standards.

West Virginia's distribution of software by telephone links through a state-wide IBM network and Wisconsin's experimentation with the use of FM radio to broadcast software provide a view to the future in this critical area. The Maryland Education Technology Network is perhaps the most advanced operational pilot study of broadcast distribution of courseware for use in a local area network for curriculum integration applications.[5]

Levels of Instructional Delivery Systems

Level I

Personal computers in a stand-alone mode using floppy disks represent a Level I CAI instructional system. CMI-CAI software applications are limited due to the large number of floppy disks needed. Sufficient quality supplementary basic skills software using drill, practice and tutorial options and single concept and applications software is expected to continue to be available to justify the use of Level I systems.

Level II

Stand-alone computers networked to a hard disk drive represent a Level II CMI-CAI system. A network connected to a 74+ megabyte hard disk drive provides the capability needed to serve 25-30 stations with courseware in mathematics, reading, language arts and science. Such a system can also include a management system that provides teachers with sufficient information to manage instruction without getting involved in extensive testing and evaluation procedures. The teacher, as a decision maker and classroom instructional manager, is worth a "lot of megabytes" and in some sense of the word is software and hardware that makes complex decisions and relates to a data base far exceeding that of any computer system.

With sufficient software, in-service training on the system, maintenance support and a well-trained lab manager, a Level II system can provide an instructional delivery system that can be offered as a comprehensive basic skills delivery system. This is more likely if the system is designed to interface with mainframes.

Level III

Professional systems, such as the one developed by WICAT, have greater storage capacity and relate to a minicomputer system with more sophisticated code, audio and graphics that provide instructional strategies not available on Level II systems at the present time.

Supporters of Level III systems provide some strong arguments for the quality of the instructional delivery system that justify its cost. Authoring systems that can develop courseware at 1/3 the cost in 1/2 the time are more than a promise. It is correct that reading and mathematics programs can require as much as 150 megabytes of storage. How much better these programs are than programs developed for a 45 to 120 megabyte hard disk is still an open question.

Enhanced computer managed instruction, computer adaptive testing, computer adaptive learning, monitoring student performance and computer based administrative applications are what really separates a Level III system from a Level II system.

Level IV

Mainframe computers with terminals relating to sophisticated administrative and communication packages appeal to school districts with large enrollments. Eventually Level II or Level III systems will be coupled with Level IV systems to provide educational networks from the classroom to the State Department of Education. The early explorers in CAI and CMI, those instrumental in developing the Stanford based CCC and University of Illinois based PLATO programs, were forerunners of Level IV systems.

Measuring the Impact of Computers in Instruction

M. D. Roblyer synthesized 23 previous reviews of research including numerous studies on instructional computing published between 1972 and 1985.[37] Five of the reviews were completed during 1975-80 using traditional +, -, = or significant differences statistical techniques. The author refers to these as pre-meta-analysis reviews of research. Seven of the reviews were completed during 1980-85 using meta-analysis.

Meta-analysis, a statistical procedure developed by Glass,[11] allows for analysis of results obtained in studies where differences in means achieved by control and experimental groups and reported in terms significant or nonsignificant T or F values or +, -, or = differences are treated as data. The method uses the concept of effect size (ES) where ES is defined as:

$$ES = \frac{\overline{XT} - \overline{XC}}{SDP}$$

$\overline{XT}$ and $\overline{XC}$ are the treatment and control group means assumed to be comparable due to an appropriate design or the use of Analysis of Covariance. SDP is the pooled standard deviation obtained by using V_T and V_C and NT and NC, the associated variances and sample sizes. It is necessary that $F = V^2_T/V^2_C$ not be statistically significant for an appropriate level.

Meta-analysis seems to oversimplify the analysis of data from numerous studies because of the lack of commonality of research designs and measures of achievement. Common systematic bias tends to produce results in a single direction. Studies tend to be published only if + or = results are obtained. However, even the critics of meta-analysis feel that the mathematics theory associated with meta-analysis justifies the technique especially when specific common criteria are met by the studies included for meta-analysis. ES values are more meaningful than specific numerical differences or +, -, = results. Appendix C provides a table of ES Values relative to the use of CMI/CAI in schools.[30]

The Center for Research in Elementary and Middle Schools at Johns Hopkins University, under the direction of Henry Becker,[2] is implementing the National Field Studies of Instructional Uses of School Computers during the 1987-88 school year. The project will concern the use of computers in mathematics instruction. The study will include a variety of approaches using computers for mathematics instruction at several grade levels. At each school, there will be two classes involved in the study. One class using computer based instruction will be compared to another using a traditional method of teaching the same subject. Although project requirements will be somewhat flexible, schools which are able to make arrangements that lead to the most scientific research designs will be given preference.

Cost Effectiveness Based on Educational Research

Some traditional methods of instruction not involving technology often result in high achievement in basic skills at a reasonable cost. Methods such as reducing class size, pull-out tutorial programs, instructional television, special teacher training programs and peer and cross-age remedial tutoring were examined. Cost analysis related to different methods of improving basic skills through supplementary activities has been reported in three studies.[10,17,25] In general, tutoring approaches were found to be the most cost effective, while reducing class size and increasing the amount of time devoted to traditional instruction were found to be the least cost effective. Computer-assisted instruction ranked between these two extremes.[30]

The IMPAC cost effectiveness study was based on average score gains and interpreted in grade equivalent gains in reading and mathematics resulting from an expenditure per student per year in each subject and relates to a $3000 yearly cost of education per student. The following table provides a summary of the results.[30]

Cost Effectiveness Per Student Per Year By Type of Instructional Intervention				
Method	*Cost Per Student Per Year	Average Grade Level Gain Math	Reading	Relative Cost Equal Effect
Tutorial (an extra 30 min/day)	$207	.5	.3	207
Reducing Class Size 30-25	$217	.2	.2	434
Reducing Class Size 25-20	$271	.3	.3	361
Increasing Regular Instructional Time in the Subject By an Extra 30 min/day	$142	.1	.2	379
Computer-assisted Instruction (12-20 minutes/day)	$135	.3	.2	216
*average cost over 5 year period				

In summary, seven different approaches to improving basic skills instruction were identified:

1. Regular textbook based instruction incorporating small group/large group instruction, pencil activities and audio visual materials (RI)
2. RI combined with pull-out instruction conducted by adult tutors
3. RI combined with highly structured higher order thinking skills and problem solving
4. Increased amount of time devoted to RI
5. RI supplemented with CMI/CAI
6. RI supplemented with enrichment activities such as LOGO, creative writing using a word processor, data bases and simulation software
7. RI with reduced class size

Basic skills minimum performance tests are likely to be a fixture in Arkansas even if there is another reform movement. The tracking of basic skills performance and individual student learning plans using CMI/CAI delivery systems are precise ways of being accountable to the State Departments of Education and the Legislature.

A caution is in order. Some CMI/CAI basic skills delivery systems that have been developed to interface with elementary school programs are being advocated as acceptable for use in adult literacy, GED, Chapter I, Students at Risk and special education programs. It may be true that some students in each of the program categories can benefit from some of the lessons, but is is not likely that the overlap is great. On the other hand, the same hardware delivery system with a menu of multipurpose courseware could serve two or more of the above groups of students in the same lab.

<u>The Complexities of Modeling, Teaching and Learning</u>

Most technology based instructional delivery systems are studied in the context of establishing an environment and method of presentation that increases the probability that students will learn that which is taught as reflected by normed or criterion reference tests. Some researchers have taken the position that student achievement should not be attributed to media but to the soundness of instructional methods even when media is incorporated.[7] New investigations are encouraged that explore the relationship between media and learning based on well conceived learning theories.[16]

The teaching/learning process is complex. Attempts to use technology as the basis of an instructional delivery system that is a replacement for teachers, or as a solution to the teacher shortage, cannot be considered serious until expert (artificial intelligence based) CMI/CAI systems can be developed to

incorporate on-task activities and management responsibilities in an environment in which off-task activities are present. Appendix D should clarify the importance of the human element in instructional processes.

It is now possible to place artificial intelligence into perspective.[38] Artificial intelligence is a mathematical system with a set of elements, operations, relationships, postulates, theorems and proofs. It has a direct application to CMI/CAI software development based on its usefulness as a model for human intelligence and as a method to create and enhance intelligence through expert systems.

Intelligence in this context involves the use of inference, knowledge representation and search and retrieval. The human brain not only performs these functions but uses them in reasoning in attempts to resolve problematic situations in which the human organism is put into a tentative state of disequilibrium. Expert systems based on the mathematics of artificial intelligence attempt to break knowledge (facts or rules for action that resolve problematic situations) into five categories: lack of knowledge, incorrect knowledge, the misapplication of knowledge, random responses and acceptable knowledge. The expert system is designed to pull the student in so that the learner's overlap of knowledge with the domain of knowledge to be acquired is increased. The study of error patterns, the mathematics of trees, and representation theory define, in part, the present status of expert systems.

A modern learning theory could relate to a psychology of learning based on imagery as an input language, behavioral psychology and Robert Steinberg's triarchal theory of intelligence.[41] His componential (analysis-critical thinking), experimental (innovative utilization of one's experience - problem solving) and contextual (manipulation of one's environment - street wise) components of intelligence expand beyond the type measured by most tests. An instructional model combining regular instruction, CMI/CAI, expert systems, problem solving, the Socratic method, and higher order thinking skills related to methods of inquiry from various disciplines (scientific method, logical discourse, historical method, delphi etc.) is suggested.

IMPAC Model For Supplementary Computer-Based Basic Skills Instruction

The Instructional Microcomputer Project for Arkansas Classrooms (IMPAC) has been testing and improving an instructional model that uses regular classroom instruction and CMI/CAI with a 4-1 mix. Students in most experimental classes work lessons on microcomputers networked to a 74 megabyte hard disk drive, either in a lab with 26 stations supervised by a teacher and a manager, or in a regular classroom with 4-8 stations. The mathematics, reading and language arts courseware, on which students spend no more than 20 percent of their instructional time, is correlated to the Arkansas Basic Skills Objectives List. The computer assisted instruction (CAI) either supplements daily instruction or provides a comprehensive parallel curriculum. In 1985 results from 212 classes indicated that students, on the average, gained two to three months on the SRA standardized test above the normal gains in classes which CAI was not used. The model or variations of the model will be implemented in 136 school districts in Arkansas by the fall of 1988.

The IMPAC Commission includes representatives of the business sector. Under their leadership the Commission established a non-profit company, IMPAC Learning Systems, Inc., to accommodate the acquisition of microcomputers, develop software and provide maintenance and support at each IMPAC project site.

IMPAC has been successful in securing hardware at a volume discount and courseware at a reduced cost under a statewide license agreement. An IMPAC lab can be designed, work stations built, rooms wired under strict electrical specifications, hardware ordered and drop shipped, hardware installed and in-service completed for the teachers and managers within three months. The program cost over a five-year period is projected to be $105 per student which is well below the cost effective level of $175 per student.

The first list of Arkansas Basic Educational Skills was published in 1980. In the fall of 1985, skills were established in the form of course content guides for every major subject area taught in grades K-8 and have been disseminated to the appropriate classroom teachers.

Once the set of objectives for a classroom is identified it becomes critical for a teacher to pinpoint the specific objectives to be taught to an individual student, a group of students or the entire class on a given day. In 1979 Arkansas began to rely heavily on the Madelyn Hunter model, the Program for Effective Teaching or PET, to help teachers improve instruction through the use of established principals of learning.

A state testing program mandated by the legislature in 1979 was fully implemented in 1980-81. Two types of testing programs were designated: a norm-referenced standardized test to be given at three grade levels and a state criterion-referenced test to be given at three other grade levels. Since the criterion-referenced test was based on the state's basic skills, this testing program added one additional set of skills, that of the norm-referenced test, which teachers needed to consider in their instruction. Although care was taken to get a good match between the skills tested by the national test and the Arkansas skills, it was quickly discovered by teachers that the way skills were tested was not always the way they had been taught. Therefore, it became important for teachers to teach skills in more than one way. Instructional management was becoming more complex and yet more vital to a good instructional program.

In the IMPAC program, a teacher is scheduled to bring students to the computer lab five days out of ten for half a period, approximately 25 minutes. Mathematics and reading/language arts software is provided along with a comprehensive management program. They utilize computer time to reinforce, review or remediate skills for students. All students may be working on the same skill, or a different skill in the same or different courses according to seven different assignment modes.

Teachers may assign students to work on CAI lessons based on specific objectives daily or they may elect to allow students to proceed through an entire set of objectives at their own pace. The management system is designed to keep both students and teachers aware of which skills are mastered. Student performance records include an individual skills profile, objectives mastered and student scores on each lesson. Teachers use this information for instructional placement to make daily lesson assignments. IMPAC requires that the school provide a system manager. However, each teacher continues to be the instructional manager.

It is important in the IMPAC model for teachers to understand they are in complete charge of their instructional program. They determine which objective(s) will be taught with CAI and how the software will supplement and enrich their regular instructional program. Some IMPAC Project teachers choose to use what is referred to as a parallel course of study, i.e. all students start at the beginning of a course and progress through the lessons at their own pace. The software covers the same overall set of skills being taught through traditional instruction. The skills may be presented in the same sequence on the computer as in the classroom; however, no attempt is made to teach them at the same time since each student is working at an individual pace.

As teachers become more comfortable with the use of computers and more familiar with the software, they see a need for other types of assignments. For instance, in order to reinforce a new skill to the entire class all students may be placed on the same CAI lesson. On the other hand, if there are students in the class who have not mastered a previously introduced skill, those students will be placed on appropriate CAI objectives to help them master that skill.

Two factors become critical when this kind of comprehensive instructional program is implemented: 1) selection of appropriate software and 2) scheduling of CAI to enhance the overall instructional program (See Appendices B,E, and F). Comprehensive supplementary CAI in a specific subject should cover at least 70 percent of the basic skill objectives included in the regular instructional program to be effective. Also, tests used to evaluate the effectiveness of an 80 percent to 20 percent mix of regular and CAI instruction should test objectives covered by the CAI, particularly those where mastery is low. Targeting specific objectives with CAI and monitoring student performance through CMI is the key to improving test scores under the IMPAC model.

With regard to scheduling it is recommended that 80 percent of the instructional time be spent in traditional instruction activities. CAI time should replace some of the time ordinarily spent on independent activities such as textbook or workbook assignments. Because CAI is a highly effective time-on-task it should be a more efficient instructional tool than the activities being replaced.

When CAI or CMI/CAI is implemented in this methodical and skill-oriented manner, significant improvement in learning is achieved. A summary of IMPAC research is provided in Appendix G.

Enrollments in IMPAC Classes

The following tables summarize the 1986-87 enrollments in mathematics, reading and language arts classes in which the IMPAC program is being used. Approximately 13% of all the students in grades 4-6 in the state are participating in the IMPAC program. The teachers and students included in the grades 7-8 study are from a subset of the grades 7-8 enrollment in all IMPAC schools. Only the experimental classes in grades 7-8 are included in the evaluation section of this report.

GRADES 4-6
ENROLLMENT

PROGRAM	#TEACHERS	MATH	READING	READING L/A	L/A
C-AIM	7	344			
C-64 CAI	29	763	139	476	101
C-128 CAI	58	287	499	611	621
CLSRM. NET. CMI/CAI	30	776	105	452	156
LAB CMI/CAI	289	6,680	1,467	3,794	2,451
APPLE IIe-CAI	178	3,988	1,079	1,997	1,180
TOTAL	591	12,838	3,289	7,330	4,509

GRADES 7-8
ENROLLMENT

PROGRAM	#TEACHERS	MATH	READING	READING L/A	L/A
LAB CMI/CAI	51	1,839	230	394	777
STAND-ALONE CAI	3	144			117
TOTAL	54	1,983	230	394	894

Evaluation of IMPAC Experimental Program
Grades 7-8

Program Evaluation By Principals

Classes at five project sites were included in the data analysis - Wynne, Rose City, Osceola, Wilson and Lake Village School Districts during 1986-87. IMPAC is indebted to the project teachers, principals and laboratory managers for their cooperation in this study.

Principals in five junior high schools were asked to evaluate the IMPAC program by responding to four questions. A summary representative of the responses is included below.

1. Reliability of equipment and maintenance provided by IMPAC
   A. 1-3 day response on repairs
   B. Equipment very reliable
   C. In-service training for Lab Managers should be more extensive in the maintenance area

2. Overall effectiveness in using CAI as a supplement to basic skills
   A. Student interest in the program has been maintained over two year period
   B. Supplementary role of CAI is working on a 1-4 mix with regular instruction
   C. Software correlations to basic skills are very helpful
   D. More language arts and reading software is needed
   E. Reports on student performance are adequate but could provide more information based on analysis of error patterns

3. Assessment of the motivation of students and teachers resulting from the IMPAC program:
   A. Over ninety-five percent of the students responded to the CAI favorably
   B. The range of software available at each grade level for each subject allows students' needs to be met except in language arts
   C. Teachers are placing students on appropriate objectives and students feel the activity is helping them
   D. CAI provides variety as an instructional technique and this is refreshing to students and teachers
   E. Immediate feedback on performance and the tutorials is effective in keeping students involved
   F. The software is designed for regular students and does not meet the needs of special education students

4. Does the program's effectiveness justify the cost, teacher time and student involvement?
   A. The 80-20 mix, which results in four 25 minute lab sessions every ten days in each of two different subjects, is an effective teaching strategy
   B. The mathematics program is the most effective program
   C. Additional reading and language arts software is needed
   D. The school's cost for the space, furniture and manager is justified - no one is complaining about the expenditures

The responses characterized by 1C, 2D, 2E, 3B, 3F and 4C relate to problems that have been addressed by IMPAC since June 1, 1987.

A two day in-service training program for lab managers was held during the summer of 1987. The program will be continued on annual basis. Over four hours of instruction was devoted to hardware and software maintenance. Language Arts 7 has been developed and is being made available to the schools and Comprehension II - reading is currently under development. Reports related to all courses are being improved based on teacher recommendations. The IMPAC program was developed for regular students since Chapter I funds provide special needs instruction for Chapter I students. No plans are being made to provide "special" software for Chapter I students.

Workshop Evaluation

The following data provides a comparison of the workshop evaluations submitted by teachers in 1985-86 IMPAC CMI-CAI grades 4-6 workshops and 1985-86 IMPAC CMI-CAI grades 7-8 workshops. The evaluation form is on the following page.

COMPARISON OF WORKSHOP EVALUATIONS		
ITEMS	1985-86 Grades 4-6	1985-86 Grades 7-8
1	6.7	6.6
2	6.6	6.7
3	6.0	6.3
4	6.7	6.5
5	6.6	6.7
6	6.5	6.4
7	6.6	6.5
8	6.2	6.3
9	6.2	6.4
#TEACHERS	192	34
#PROGRAMS	23	5

There is no significant difference in the teacher's evaluations of the CMI-CAI grades 4-6 workshops and the teacher's evaluations of the CMI-CAI grades 7-8 workshops. The workshop topics were covered very well in the opinion of over 92% of all teachers participating.

Evaluation form used in evaluating IMPAC in-service for Apple IIe CMI-CAI teachers (Grades 4-6 and 7-8).

Date_____IMPAC School_____Grade_____

Please complete as accurately as possible. Your time and cooperation are greatly appreciated.

1. How relevant were the ideas to your work: Relevant 7 6 5 4 3 2 1 Irrelevant
2. The session was: Organized 7 6 5 4 3 2 1 Disorganized
3. Was there adequate time to cover the material? Adequate 7 6 5 4 3 2 1 Inadequate
4. The session's learning activities were: Interesting 7 6 5 4 3 2 1 Dull
5. The information I received should prove: Useful 7 6 5 4 3 2 1 Useless
6. To what extent do you plan to implement the concepts presented? Extensively 7 6 5 4 3 2 1 Not at all
7. How clear were the objectives for this session? Clear 7 6 5 4 3 2 1 Vague
8. How well did the presenters hold your interest? Very Well 7 6 5 4 3 2 1 Not at all
9. How prepared were the presenters? Prepared 7 6 5 4 3 2 1 Ill-Prepared
10. What did you like best about the workshop?
11. What did you like least?
12. Suggestions for improvement.
13. Comments.
    (Use the back if more room is needed.)

Teacher Evaluation of Program

The fourteen evaluation items are arranged in four groupings. The analysis of data relates to teacher responses in grades 4-6 and grades 7-8 in order to determine if the IMPAC CMI/CAI programs are comparable. The four groupings are hardware, mathematics courseware, lanugage arts/reading couseware and program assistance.

COMPARISON OF TEACHER EVALUATION OF PROGRAM BY GRADES 4-8 - AVERAGE ON SIX POINT LIKERT SCALE -

	HARDWARE			MATH COURSEWARE				LA/R COURSEWARE				ASSISTANCE			Avg
ITEM/GRD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
4	5.7	5.2	5.5	5.0	5.5	5.5	5.5	5.0	5.6	5.1	5.1	5.6	5.5	4.8	5.3
5	5.4	5.5	5.7	5.3	5.4	5.3	5.3	4.9	5.0	4.7	5.2	5.8	5.4	5.0	5.3
6	5.1	4.6	5.2	5.2	5.2	5.6	5.2	4.7	5.1	5.1	5.2	5.3	5.4	5.0	5.1
7	5.8	5.0	5.9	4.9	5.1	5.4	5.5	4.1	4.1	5.1	4.4	5.8	5.6	4.9	5.3
8	6.0	5.2	5.7	4.8	5.9	5.6	5.7	3.8	3.8	4.2	4.6	5.9	5.6	4.4	5.2
Comp. Avg.	5.5	5.0	5.5	5.1	5.3	5.5	5.4	4.7	5.0	4.9	5.1	5.6	5.4	4.9	5.2

There is no significant difference between the evaluations related to hardware by teachers in grades 4-6 and teachers in grades 7-8.

There is no significant difference between the evaluations related to math courseware by teachers in grades 4-6 and teachers in grades 7-8.

There is a significant difference between the evaluations related to language arts/reading courseware by teachers in grades 4-6 and teachers in grades 7-8. The evaluations were much lower for the grades 7-8 program.

The assistance provided to teachers in grades 4-6 and grades 7-8 was essentially the same.

Evaluations of IMPAC Programs By Project Teachers

A Likert scale was developed related to the effectiveness, moderate effectiveness or ineffectiveness of various aspects of the IMPAC programs. The scale, 0-6, was used with fourteen questions related to mathematics software, reading and language arts software, program effectiveness in the classroom and technical support from vendors, IMPAC staff and local coordinators.

Scale Definition

Teachers completing the evaluation form were asked to select a number 0-6 according to the following instructions:

6 -- Effective - not perfect but no improvement is needed
5 -- Effective - program can be improved at either the classroom, building, or district level without help from IMPAC
4 -- Effective - program can be improved with help from IMPAC
3 -- Moderately effective - Improvement cannot be justified in light of other needs
2 -- Ineffective - Improvement can be made at either the classroom, building or district level without help from IMPAC
1 -- Ineffective - Improvement can be made only with help from IMPAC
0 -- Ineffective - No improvement can be made

The 0-6 scale not only served as a rating system but also provided directions for program improvement.

Evaluation of IMPAC By Project Teachers

IMPAC Project School/District_____
Teacher_____ Grade Level_____
Classroom Organization (Please Check One):
Self-contained_____ Departmentalized_____ Semi-Departmentalized_____
Number of days during a ten day period a student has lessons on a computer.(Ex: 5/10 means 5 days in 10):
Language Arts and Reading_____Math_____
Number of minutes of regular scheduled time (do not include computer time):
Language Arts and Reading_____Math_____

Please read and rank each item according to the following scale:
6 -- Effective - not perfect but no improvement is needed
5 -- Effective - program can be improved at either the classroom, building, or district level without help from IMPAC
4 -- Effective - Program can be improved with help from IMPAC
3 -- Moderately Effective - Improvement cannot be justified in light of other needs
2 -- Ineffective - Improvement can be made at either the classroom, building, or district level without help from IMPAC
1 -- Ineffective - Improvement can be made only with help from IMPAC
0 -- Ineffective - No improvement can be made

_____ 1. Effectiveness of the number of computers for student use

_____ 2. Effectiveness of your microcomputers in presenting the CAI lessons

_____ 3. Effectiveness of IMPAC in keeping your computers, monitors, and disk drives working

_____ 4. Effectiveness of the amount of math software

_____ 5. Effectiveness of the math software in basic skills instruction

_____ 6. Your effectiveness in using CAI as a supplement to your basic mathematics instructional program

_____ 7. Effectiveness of the IMPAC program in your classroom in helping you improve basic instruction in math

_____ 8. Effectiveness of the amount of reading and language arts software

_____ 9. Effectiveness of the reading and language arts software in basic skills instruction

_____10. Your effectiveness in using CAI as a supplement to your basic reading and language arts instructional program

_____11. Effectiveness of the IMPAC program in your classroom in helping you improve basic instruction in reading and language arts

_____12. Effectiveness of the assistance provided to you by other teachers or supervisors at the local level

_____13. Effectiveness of the IMPAC in keeping your software working

_____14. Effectiveness of the assistance provided to you by IMPAC in solving problems relating to service or equipment, need for more software, need for software storage, and in-service training

Average Percentile Gains By Classes

The table below indicates the number of mathematics and language arts classes in grades 7-8 used in the study from five different junior high schools: Rose City, North Little Rock, Wynne, Osceola, Wilson and Lake Village.

#Classes		
Grade	Math	LA
7	31	10
8	15	15

The table below indicates the average percentile gains based on MAT6 scores provided by the school districts and the psychological corporation. The gains relate to improved scores resulting from instructional intervention when the experimental (IMPAC) classes were compared to the control (regular instruction) classes. Analysis of covariance was used to make adjustments in initial differences in class pretest scores when the technique was needed.

Average Percentile Gains		
Grade	Math	LA
7	13-17%	7-11%
8	9-13%	6-8%

Thirty-nine of the 46 mathematics classes showed positive gains and 21 of the 25 language arts classes showed positive gains. The results are comparable to the results IMPAC has obtained from research related to grades 4-6 mathematics classes. However, the results related to language arts are significantly less for grades 7-8 classes when compared to gains in grades 4-6 classes.

The table below provides additional information about the test results. The following example is an interpretation of one line of the data. In grade 7 there were 695 students in 31 experimental classes that used the IMPAC Learning System following the guidelines described on pages 10-11. The average additional grade equivalent gain of 0.24 refers to the statistical weighted mean of the 31 class averages interpreted as a grade equivalent score. That score in the experimental classes exceeds that of the weighted mean grade equivalent score for the control group classes by 0.24 (2.4 months). The standard error (SE) of the mean score in the table is sufficiently small for six (starred entries) of the statistics to be significant at the $\alpha = 0.01$ level.

ADDITIONAL GRADE EQUIVALENT GAINS CONTRIBUTED TO THE IMPAC PROGRAM 1986-87 IMPAC CMI/CAI LAB GRADES 4-8

GRADE	SUBJECT	# STUDENTS IN SAMPLE	# CLASSES	ADJUSTED AVG. ADD. GRADE EQUIV. GAIN	SE
4	Mathematics	346	17	0.27*	0.113
5	Mathematics	665	30	0.34*	0.080
6	Mathematics	839	37	0.30*	0.096
7	Mathematics	695	31	0.24*	0.096
8	Mathematics	335	15	0.20	0.146
4	Language Arts	324	16	0.24	0.147
5	Language Arts	552	25	0.28*	0.106
6	Language Arts	734	31	0.25*	0.108
7	Language Arts	215	10	0.18	0.170
8	Language Arts	336	15	0.12	0.155

Maintenance Study

IMPAC maintained detailed records related to the cost of the maintenance of all the hardware used in IMPAC projects April 1, 1986, through March 31, 1987. The records relate to 1458 Apple //e, 192 Commodore 64 and 198 Commodore 128 microcomputers. No attempt was made to separate maintenance costs in junior high schools from costs in all IMPAC programs. The study included records on 1848 microcomputers, 1548 floppy drives, 46 hard disk drives, 1848 monitors and 303 printers. Of these 5593 components of hardware 379 repairs were made on site, at the IMPAC office or subcontracted. High standards for hardware installations, preventive maintenance, in-service training on the care and use of equipment and covers for all hardware components accounts for most of the decrease in the percentage of defective components.

Table A below shows that the repair rate has decreased from 19.75% to 6.78%. Table B shows that the maintenance cost/component has decreased from $34.71 to $21.10. Table C provides a comparison between the cost of a regular commercial vendor contract for repairs on IMPAC hardware, a typical commercial vendor's actual cost to service IMPAC hardware and IMPAC's actual maintenance cost on 5593 hardware components in all IMPAC project schools during the period April 1, 1986 - March 31, 1987. The IMPAC maintenance program saved the IMPAC project schools $80,000 during the 12 month period studied.

TABLE A

YEAR	COMPONENTS	#REPAIRS	PERCENT
1984-85	1023	202	19.75%
1986-87	5593	379	6.78%

TABLE B

YEAR	COMPONENTS	MAINTENANCE COST	COST/COMPONENTS
1984-85	1023	$35,511	$34.71
1986-87	5593	$118,005	$21.10

TABLE C

YEAR	VENDOR CONTRACT	VENDOR ACTUAL COST	IMPAC COST
1986-87	$198,853	$166,457	$118,005

The following tables provide detailed information on the rate of repairs for each component of the three different types of microcomputers used in IMPAC. TABLE D relates to Apple //e projects and TABLE F and TABLE G to Commodore projects. TABLE E provides the cost analysis related to the maintenance cost of a typical IMPAC Apple //e Corvus Omninet hard disk drive CMI/CAI network program. Under normal conditions a school district should expect to pay a vendor $3000 - $3600 per year for these services. It is reasonable to assume that IMPAC is providing maintenance for its laboratories at a 40% savings to Arkansas school districts.

TABLE D

APPLE HARDWARE DEFECTIVE RATE

COMPONENTS	# UNITS	# REPAIRED	PERCENT DEFECTIVE
Uni-Disk Drive (5.25)	1068	41	3.84
Monitor - Apple //e Mono.	1234	37	3.00
Monitor - Apple //e Color	224	8	3.57
CPU (128K)	1458	64	4.39
Printer - LX 80	239	6	2.51

TABLE E

EXPECTED COST TO MAINTAIN AN APPLE //e CMI/CAI IMPAC LAB

COMPONENTS	DEFECTIVE/REPLACEMENT RATE	REPAIR UNIT COST	COST
26 CPU's (128K)	.0439	90	$103
26 Keyboards (Built in)	.0123	90	29
22 Monitors Apple //e Monochrome	.0300	90	29
4 Monitors Apple //e Color	.0357	90	13
5 Uni-Disk Drives (5.25)	.0384	90	17
2 Printers - LX 80	.0251	90	5
1 Corvus 74 Megabyte Hard Disk Drive Ntwk	1.37	600	822
1 On site Preventive Maintenance	1	350	350
3.89 Parts	1	65	253
4 Ribbons	1	14	14
2 Boxes Paper	1	60	60
29 Hardware Covers (5 Yr. cost)	.2	10	58
		TOTAL COST	$1783

TABLE F

COMMODORE 64 HARDWARE DEFECTIVE RATE			
COMPONENTS	# UNITS	# REPAIRS	PERCENT DEFECTIVE
Uni-Disk Drive 1541	240	24	10.0
Monitor 1702 Color	192	11	5.73
CPU (64K)	192	27	14.06
Power Pack (Regular)	192	25	13.02
Printer 1526	48	2	4.17
Keyboard	192	5	2.60

TABLE G

COMMODORE 128 HARDWARE DEFECTIVE RATE			
COMPONENTS	# UNITS	# REPAIRS	PERCENT DEFECTIVE
Uni-Disk Drive (5.25) 1571	240	16	6.67
Monitor RGBI-1902	198	10	5.05
CPU (128K)	198	16	8.08
Power Pack (Heavy Duty)	198	4	2.02
Printer MPS 1000	16	0	0.00
Keyboard	198	3	1.52

Utilization of IMPAC Program in the Remediation of Basic Skills Grade 6 and Grade 8

Two experiments specifically related to the remediation of students failing the Arkansas Minimum Performance Test (MPT) were conducted at Rose City Junior High School in the North Little Rock School District and the C.D. Franks Intermediate School in the Ashdown School District during the summer of 1987.

The Rose City Junior High program involved 52 of the 200 students from the district that had failed the 8th grade MPT. The program was directed by Greg Thompson and used the following model:

A. Fifty-two 8th grade students in classes of 8-10 directed by 6 teachers

B. Three subjects - mathematics/reading/language arts

C. A 75 minute period in each subject of which 25 minutes was devoted to CAI computer work

D. A program length of 25 days with 3 days devoted to evaluation during a five week period in June and July

The average gain based on this model was a 1.8 grade equivalent composite score based on different forms of a MAT6 pretest/post-test.

The Ashdown program involved 24 of the 32 students in the district that failed at least one section of the sixth grade MPT. The program director was Barabara Prather. The model included:

A. Three classes of 8 students each

B. One elementary teacher knowledgeable of the curriculum in grades 3-8 in reading, mathematics and language arts directed the program and was assisted by a laboratory manager

C. One subject taught each day - 90 minute periods for each class in the IMPAC laboratory

D. Mathematics taught on Monday, Reading on Tuesday and Language Arts on Wednesday

E. There was no regular instruction

F. A time period of 6 weeks that ended 1 week prior to the beginning of school

Twenty-two of the 24 students remediated all objectives that had been failed on the MPT. Records were printed out that provided evidence of remediation.

IMPAC will provide technical assistance, maintenance and in-service training for all IMPAC programs that operate during the summer for the purpose of remediation. In addition to the current 46 laboratories an additional 21 will be added this year and could be used during the summer of 1988.

The quantity of IMPAC software will be extended to include additional language arts, reading and science software by the summer of 1988. Currently the mathematics software covers 90% of the minimum performance objectives, 70% of the language arts objectives and 40% of the reading objectives for grades 3-8. The program's effectiveness will increase with the additional software and additional improvements in the management system.

Summary and Conclusions

The IMPAC Supplementary Basic Skills Learning System is as effective and comprehensive in mathematics in grades 7-8 as it is in grades 4-6. The program is only about 50% as effective in language arts. It is very likely that this difference resulted from the fact that the language arts courseware for grades 7-8 is not as comprehensive as the courseware used in grades 4-6.

The IMPAC in-service training and maintenance programs were equally effective in grades 7-8 and grades 4-6. The average cost of a laboratory program in either grades 4-6 or grades 7-8 is $104/student based on a 5 year life for the program. The average cost per laboratory for maintenance was $1800 per site.

The appropriate instructional time for CAI from both the learner and teacher standpoint is 20-25 minutes every other day in a specific subject, such as mathematics or language arts, but not to exceed four CAI sessions every ten days. The regular instructional activities (non-CAI related) are critical and the 80 percent regular instruction in grades 7-8 and 20% CAI is just as vital as in the grades 4-6 IMPAC programs.

Achievement gain in language arts is about 70 percent of the gain in mathematics when instruction is supplemented with CAI. However, with additional basic skills correlated language arts software for grades 7-8, this difference in effectiveness may not continue. IMPAC expects to add additional Language Arts 7 and Language Arts 8 software to the program during 1987-88 school year. Over ninety percent of the students and teachers have a very positive attitude toward the efficient use of computers in a laboratory setting. The reliability of equipment, comprehensiveness of software, in-service training, documentation, maintenance services and program supervision contribute to this result.

The IMPAC management system tracks student performance. Based on decisions made by teachers, specific objectives can be assigned to be remediated by students. This process of targeting specific objectives enhanced by the manager makes CAI more effective. Evidence to be presented in a later report will indicate that performance in the IMPAC CAI stand-alone non-management based program during 1985-87 was significantly less than the performance in the CMI-CAI program for grades 4-6. It is likely that this would be true for grades 7-8.

The IMPAC Supplementary Basic Skills Learning System can be utilized in the summer to remediate students in grades 6 and 8 that have failed the MPT. The system is best used in connection with regular instruction over a 3-5 week period in which CAI activities do not exceed fifty percent of the instruction but is not less than 33 percent. Although this conclusion is based on only two pilot projects, results from seven other sites have been recently reviewed and enhances its credibility.

Appendix A
CMI/CAI Instructional Model

Interface Between Program for Effective Teaching (PET) and CMI/CAI

PET Instruction Concept	CMI	CAI
Objective Based	X	X
Objectives at Appropriate Levels		X
Diagnostic Questions	X	X
Assignment Modes Group/Individual	X	
Concept Development		X
Guided Activities (Immediate Feedback)	X	
Involve Learner in Learning Process		X
Drill and Practice		X
Intermittent Practice		X
Problem Solving		X
Knowledge of Results	X	X
Positive Reinforcement		X
Storage of Records	X	X
Retrieval of Records	X	X
Mastery Questions	X	X
Control of Learning		X
Curriculum Alignment	X	

Appendix B
IMPAC COURSEWARE

COURSE	GRADES	#OBJECTIVES	#LESSONS
MATH I	3-4-5	47	378 (73 games)
MATH II	4-5-6	37	247 (60 games)
MATH III	5-6-7	46	302 (39 games)
GRD 4	3-4-5	35	196
GRD 5	4-5-6	46	230
GRD 6	5-6-7	38	198
GRD 7	6-7-8	43	196
GRD 8	7-8-9	50	260
LA 3	3-4	48	96
LA 4	3-4-5	38	76
LA 5	4-5-6	46	92
LA 6	5-6-7	46	92
LA 7	6-7-8	19	251
Comprehension I	4-6	45	352
Word Perception	2-5	38	114
Science	4-6	18	54
Funwriter	6	X	X
Testing Program	All grades	X	X
Principals Data Base	All Students	X	X
16 Courses	Grades 3-8	650	3,134 (172 games)

Courseware is provided under a state license from Ideal Learning, Inc., or was developed under contract for IMPAC by Robert Essertier, or the University of Arkansas Center of Interactive Technology, Fayetteville, Arkansas.

IMPAC LEARNING SYSTEMS

OBJECTIVE NAMES OF LA3 ### OBJECTIVE NAME	OBJECTIVE NAMES OF LA4 ###OBJECTIVE NAME
1. COMPLETE OR INCOMPLETE THOUGHTS	1. COMPLETE & INCOMP. SENTENCES
2. INTRODUCTION TO NOUNS	2. SUBJECTS & SIMPLE PREDICATES
3. DIFF. BETWEEN SUBJECTS & PRED.	3. SIMPLE SUBJECTS & SIMPLE PRED.
4. DIFF. BETWEEN PREDICATES & SUBJ.	4. STATEMENTS AND QUESTIONS
5. STATEMENTS AND QUESTIONS	5. COMMANDS AND EXCLAMATIONS
6. COMMAND SENTENCES	6. FOUR KINDS OF SENTENCES
7. EXCLAMATIONS	7. INTRODUCTIONS TO NOUNS
8. FOUR KINDS OF SENTENCES	8. COMMON AND PROPER NOUNS
9. ENDING PUNCTUATION OF SENTENCES	9. PLURAL NOUNS: ADD S TO THE SING.
10. HOW SENTENCES BEGIN AND END	10. PLUR. OF NOUNS: S,X,CH,SH ENDING
11. REVIEW OF SUBJECTS & PREDICATES	11. PLURAL NOUNS: CONS. & Y ENDINGS
12. COMBINING OF SUBJECTS	12. PLURALS OF IRREGULAR NOUNS
13. COMBINING OF PREDICATES	13. SINGULAR POSSESSIVE NOUNS
14. COMBINING OF SENTENCES	14. PLURAL POSSESSIVE NOUNS
15. NOUNS	15. ACTION VERBS
16. COMMON AND PROPER NOUNS	16. LINKING VERBS
17. DAYS & MONTHS AS PROPER NOUNS	17. PRESENT TENSE VERBS
18. NAMES & ABBREV. AS PROPER NOUNS	18. PAST TENSE VERBS
19. TITLES AS PROPER NOUNS	19. ACTION VERBS: PRES. & PAST TENSE
20. NAMES OF PLACES AS PROPER NOUNS	20. PAST TENSE OF IRREGULAR VERBS
21. SINGULAR AND PLURAL NOUNS	21. VERB PHRASES
22. PLURAL NOUNS WITH -ES ENDING	22. CONTRACTIONS
23. PLUR. NOUNS OF CONS. & Y ENDING	23. ADJECTIVES
24. SINGULAR POSSESSIVE NOUNS	24. KINDS OF ADJECTIVES
25. PLURAL POSSESSIVE NOUNS	25. ADJECTIVES: COMP. & SUPERL. FORM
26. IRREGULAR PLURAL & POSS. NOUNS	26. ARTICLES: A, AN, THE
27. VERBS	27. ADVERBS
28. VERBS IN A SENTENCE	28. ADVERBS: HOW, WHEN, WHERE
29. VERBS IN THE PRESENT TENSE	29. USE OF NEGATIVE WORDS
30. VERBS IN THE PAST TENSE	30. PRONOUNS
31. PRES. TENSE VERB WITH SING. SUBJ.	31. SUBJECT PRONOUNS
32. PRES. TENSE VERB WITH PLUR. SUBJ.	32. PRO. USED AFTER ACTION VERBS
33. SPELLING RULES OF VERBS	33. POSSESSIVE PRONOUNS
34. SPELLING OF VERBS IN PAST TENSE	34. PRONOUNS: I, ME, WE, US
35. VERBS USING HAS AND HAVE	35. SYNONYMS
36. IRREG. VERBS USING HELPING VERBS	36. ANTONYMS
37. PRONOUNS	37. HOMOPHONES
38. PRONOUNS USED AS SUBJECTS	38. HOMOGRAPHS
39. PRONOUNS USED IN THE PREDICATE	39.
40. THE USE OF "I" AND "ME"	40.
41. POSSESSIVE PRONOUNS	41.
42. ADJECTIVES	42.
43. KINDS OF ADJECTIVES	43.
44. ARTICLES: A, AN, THE	44.
45. SYNONYMS	45.
46. ANTONYMS	46.
47. HOMOPHONES	47.
48. HOMOGRAPHS	48.
49.	49.
50	50.

IMPAC LEARNING SYSTEMS

OBJECTIVE NAMES OF LA5 ### OBJECTIVE NAME	OBJECTIVE NAMES OF LA6 ### OBJECTIVE NAME
1. SENTENCES	1. SENTENCES
2. DECLARATIVE & INTERROG. SENTENCES	2. DECLARATIVE & INTERROG. SEN.
3. IMPERATIVE & EXCLAMATORY SENT.	3. IMPERATIVE & EXCLAMATORY SENT.
4. COMPLETE SUBJECTS & PREDICATES	4. FOUR KINDS OF SENTENCES
5. SIMPLE SUBJECTS	5. SIMPLE SUBJECTS
6. SIMPLE PREDICATES	6. SUBJECTS IN UNUSUAL POSITIONS
7. SUBJECT OF AN IMPERATIVE SENT.	7. SIMPLE PREDICATES
8. HOW SENTENCES END	8. SENTENCES: CAPITALS & PUNC.
9. NOUNS	9. COMMAS, COLONS AND PERIODS
10. COMMON AND PROPER NOUNS	10. NOUNS
11. SINGULAR AND PLURAL NOUNS	11. COMMON AND PROPER NOUNS
12. IRREGULAR PLURAL NOUNS	12. SINGULAR AND PLURAL NOUNS
13. SING. & PLURAL POSSESSIVE NOUNS	13. POSSESSIVE FORMS OF NOUNS
14. ABBREVIATIONS AND INITIALS	14. ABBREVIATIONS
15. ACTION VERBS	15. ACTION VERBS
16. LINKING VERBS	16. LINKING VERBS
17. HELPING VERBS	17. HELPING VERBS AND MAIN VERBS
18. DIRECT OBJECTS	18. OBJECTS OF A VERB
19. VERBS: PRESENT, PAST & FUTURE	19. VERBS: PRESENT, PAST & FUTURE
20. PRESENT TENSE VERBS	20. AGREEMENT OF SUBJECT AND VERB
21. PAST TENSE VERBS	21. PARTICIPLE FORMS OF VERBS
22. IRREG. VERBS: PARTICIPLE FORMS	22. TROUBLESOME VERBS
23. TROUBLESOME VERBS	23. PRONOUNS
24. PRONOUNS	24. SUBJECT PRONOUNS
25. SUBJECT PRONOUNS	25. OBJECT PRONOUNS
26. OBJECT PRONOUNS	26. POSSESSIVE PRONOUNS
27. POSSESSIVE PRONOUNS	27. SUBJECT AND OBJECT PRONOUNS
28. USE OF "I" AND "ME"	28. PRONOUN-VERB AGREEMENT
29. ADJECTIVES	29. ADJECTIVES
30. ADJECTIVES AFTER LINKING VERBS	30. ADJECTIVES: COMP. & SUPERL. FORM
31. ADJECTIVES THAT COMPARE (ER,EST)	31. ADJECTIVES USING MORE AND MOST
32. ARTICLES: A, AN, THE	32. CAPITALIZATION OF PROPER ADJ.
33. ADVERBS	33. DEMONSTRATIVE WORDS: ADJ/PRON
34. ADVERBS & ADJECTIVES IN SENT.	34. ADVERBS
35. ADVERBS THAT COMPARE	35. COMMONLY-USED ADVERBS
36. WORDS USED AS AN ADVERB OR ADJ.	36. ADVERBS: COMP. & SUPERL. FORMS
37. PREPOSITIONS	37. WORDS USED AS AN ADVERB OR ADJ
38. PREPOSITIONAL PHRASES	38. PREPOSITIONS & PREP. PHRASES
39. PREP. & ADVERBS IN SENTENCES	39. PREPOSITIONAL PHRASES AS ADJ.
40. COMPOUND SUBJECTS	40. PREPOSITIONAL PHRASES AS ADV.
41. COMPOUND PREDICATES	41. SIMPLE AND COMPOUND SENTENCES
42. COMPOUND SENTENCES	42. COMPOUND SUBJECTS & PREDICATES
43. SYNONYMS	43. SENTENCES, FRAGMENTS & RUN-ONS
44. ANTONYMS	44. CONJUNCTIONS
45. HOMOPHONES	45. SYNONYMS AND ANTONYMS
46. HOMOGRAPHS	46. HOMOPHONES AND HOMOGRAPHS
47.	47.
48.	48.
49.	49.
50.	50.

IMPAC LEARNING SYSTEMS

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OBJECTIVE NAMES OF LA7 ###OBJECTIVE NAME	OBJECTIVE NAMES OF COMPREHENSION I ### OBJECTIVE NAME
1. INTRODUCTION TO SENTENCES	1. INSTRUCTIONS
2. KINDS OF SENTENCES	2. WORD MEANING I
3. INTRODUCTION TO VERBS	3. CLASSIFYING WORDS
4. MORE ABOUT VERBS	4. LITERAL DETAILS I
5. INTRODUCTION TO NOUNS	5. LITERAL MAIN IDEA I
6. MORE ABOUT NOUNS	6. LITERAL SEQUENCE I
7. INTRODUCTION TO PRONOUNS	7. LITERAL COMPARISON I
8. MORE ABOUT PRONOUNS	8. LITERAL CAUSE-EFFECT I
9. ADJECTIVES	9. LITERAL CHAR. TRAITS I
10. ADVERBS	10. USING PUNCTUATION
11. PREPOSITIONS	11. UNDERSTANDING PRONOUNS
12. CONJUNCTIONS	12. WORD MEANING II
13. INTERJECTIONS	13. INFERENTIAL DETAILS I
14. THE EIGHT PARTS OF SPEECH	14. INFERENTIAL MAIN IDEA I
15. COMPOUND AND COMPLEX SENTENCES	15. INFERENTIAL DEQUENCE I
16. CAPITALIZATION	16. INFERENTIAL COMPARISON I
17. THE USE OF COMMAS	17. INFERENTIAL CAUSE-EFFECT I
18. OTHER PUNCTUATION	18. INFERENTIAL CHAR. TRAITS I
19. SPECIAL WORDS	19.
20.	20. PREDICTING OUTCOMES I
21.	21. FIGURATIVE LANGUAGE I
22.	22. REALITY VS. FANTASY I
23.	23. FICTION VS. NONFICTION
24.	24. CLASSIFYING WORDS II
25.	25.
26.	26. LITERAL DETAILS II
27.	27. LITERAL MAIN IDEA II
28.	28. LITERAL SEQUENCE II
29.	29. LITERAL COMPARISON II
30.	30. LITERAL CAUSE-EFFECT II
31.	31. LITERAL CHAR. TRAITS II
32.	32. PUNCTUATION II
33.	33. PRONOUNS II
34.	34.
35.	35. INFERENTIAL DETAILS II
36.	36. INFERENTIAL MAIN IDEA II
37.	37. INFERENTIAL SEQUENCE II
38.	38. INFERENTIAL COMPARISON II
39.	39. INFERENTIAL CAUSE-EFFECT II
40.	40. INFERENTIAL CHAR. TRAITS II
41.	41. PREDICTING OUTCOMES II
42.	42. FIGURATIVE LANGUAGE II
43.	43. REALITY VS. FANTASY II
44.	44. FICTION VS. NONFICTION II
45.	45. FACT VS. OPINION II
46.	46.
47.	47.
48.	48.
49.	49.
50.	50.

IMPAC LEARNING SYSTEMS

OBJECTIVES NAMES OF MATH I ### OBJECTIVE NAME	OBJECTIVE NAMES OF MATH II ### OBJECTIVE NAME
1. INTRODUCING NUMBERS	1. REVIEW OF MULTIPLICATION
2. EASIER ADDITION FACTS	2. DIVISION CONCEPTS
3. HARDER ADDITION FACTS	3. LONG DIVISION (2 & 3 PLACE)
4. EASIER SUBTRACTION FACTS	4. WHOLE # WORD PROBLEMS (EASY)
5. COUNTING BY 5'S & 10'S	5. WHOLE # WORD PROBLEMS (HARD)
6. ADD 2-DIGIT # (NO REGROUPING)	6. ESTIMATION SKILLS
7. IDENTIFY PLACE VALUE (3-DIGITS)	7. DISCRIMINATE ODD AND EVEN
8. ORDINAL NUMBERS	8. IDENTIFY FRACTIONS 1/2 1/3 1/4
9. ADD 2-DIGIT # (REGROUPING)	9. IDENTIFY FRACTIONS FROM PICS
10. WHOLE NUMBER ADDITION	10. ADD & SUB FRACS (NO REGROUPING)
11. HARDER SUBTRACTION FACTS	11. FIND EQUIVALENT FRACTIONS
12. SUBTRACT 2-DIGIT # (NO REGROUPING)	12. FIND LARGEST FRAC IN SET (EASY)
13. NUMBER SEQUENCES	13. SIMPLIFY PROPER FRACS (EASY)
14. SUBTRACT 2-DIGIT # (REGROUPING)	14. SIMPLIFY PROPER FRACS (HARD)
15. COST AND CHANGE UNDER A DOLLAR	15. MIXED & IMPROPER CONVERSIONS
16. SUBTRACT 3-DIGIT # (EASIER)	16. FIND LCM AND GCF
17. IDENTIFY TIME/READ A CLOCK	17. ADD PROPER FRACS W/REGROUPING
18. WHOLE NUMBER SUBTRACTION	18. ORDER FRACTIONS BY SIZE
19. IDENTIFY PLACE VALUE (5-DIGITS)	19. SUB PROPER FRACS W/REGROUPING
20. ADDITION & SUBTRACTION REVIEW	20. ADD & SUB WITH MEASUREMENTS
21. NAMING NUMBERS	21. ADD MIXED FRAC W/REGROUPING
22. ADDITION & SUBTRACTION WORD PROB	22. SUB MIXED FRACS NO REGROUPING
23. EASIER MULTIPLICATION FACTS	23. SUB MIXED FRACS W/REGROUPING
24. HARDER MULTIPLICATION FACTS	24. PRIME NUMBERS & FRACTIONS
25. SIMPLE INEQUALITIES	25. FIND FRACTION BETWEEN 2 OTHERS
26. MONEY - SIGN AND DECIMAL POINT	26. MULTIPLY PROPER FRACTIONS
27. INCH / FT. / YRD.	27. INTRO TO DIVIDE FRACTION
28. 4-DIG # X 1-DIG # MULTIPLICATION	28. COMPLEX FRACTIONS
29. 2-DIG # X 2-DIG # MULTIPLICATION	29. ADD & SUB FRACTION WORD PROBS
30. ADD, SUB & MULT WORD PROBLEM	30. MULTIPLY ANY FRACTIONS
31. 3-DIG # X 2-DIG # MULTIPLICATION	31. DIVIDE ANY FRACTIONS
32. MISSING FACTORS	32. MULT & DIV FRACTION WORD PROBS
33. EASIER DIVISION FACTS	33. DECIMALS-TENTHS & HUNDREDTHS
34. 4-DIG # X 2-DIG # MULTIPLICATION	34. CONVERT 2 PLACE DECIMAL TO FRAC
35. HARDER DIVISION FACTS	35. ORDER DECIMAL #'S
36. MISSING QUOTIENTS	36. ADD DECIMALS-10THS & 100THS
37. 4-DIG # X 3-DIG # DIVISION	37.
38. 1-DIG # DIVISION (NO REMAINDER)	38.
39. 1-DIG # DIVISION (REMAINDER)	39.
40. EASIER 2-DIG # DIVISION	40.
41. HARDER 2-DIG # DIVISION	41.
42. WORD PROBLEMS WITH WHOLE NUMBERS	42.
43. REVIEW OF WHOLE NUMBERS	43.
44. ROUNDING NUMBERS	44.
45. LCM AND GCF	45.
46. ODD AND EVEN NUMBERS	46.
47.	47.
48.	48.
49.	49.
50. STUDENT INSTRUCTIONS	50. STUDENT INSTRUCTIONS

IMPAC LEARNING SYSTEMS

OBJECTIVE NAMES OF MATH III ### OBJECTIVE NAME	OBJECTIVE NAMES OF GRD4 ### OBJECTIVE NAME
1. ADD FRACTIONS REVIEW	1. NUMERATION AND ORDER
2. SUBTRACT FRACTIONS REVIEW	2. W.N. CONCEPTS USING PLACE VALUE
3. MULTIPLY & DIVIDE FRACS REVIEW	3. NUMBER SENTENCES USING W.N.
4. INTRO TO DECIMAL NOTATION	4. EVEN AND ODD NUMBERS
5. DEFINITIONS IN GEOMETRY	5. OTHER NUMERATION SYSTEMS
6. ORDERING DECIMAL NUMBERS	6. ADDITION CONCEPTS-W. NUMBERS
7. ROUNDING DECIMAL NUMBERS	7. APPLICATIONS WITH W.N. ADDITION
8. ADDITION OF DECIMAL NUMBERS	8. SUBTRACTION CONCEPTS-W. NUMB
9. SUBTRACTION OF DECIMAL NUMBERS	9. APPLICATIONS WITH W.N. SUBT.
10. DEC X WHOLE MULTIPLICATION	10. MULTIPLICATON CONCEPTS-W.N.
11. DEC DIVIDED BY WHOLE (EASIER)	11. APPLICATIONS WITH W.N. DIVISION
12. DECIMAL X DECIMAL MULTIPLICATION	12. DIVISION CONCEPTS-W. NUMBERS
13. FIND DEC BETWEEN TWO OTHERS	13. APPLICATIONS WITH W.N. DIVISION
14. CONVERSIONS BETWEEN FRACS & DECS	14. BASIC GEOMETRIC FIGURES
15. OPERATIONS WITH FRACS & DECIMALS	15. FIGURES IN THE PLANE
16. ADD & SUB DECIMAL WORD PROBLEMS	16. SOLIDS
17. DEC DIVIDED BY WHOLE (HARDER)	17. DIVISIBILITY
18. INTRO TO PERCENTS	18. FACT-PRIME/COMPOSITE/COMMON
19. ROMAN NUMERALS	19. INTRODUCTION TO FRACTIONS
20. FIND PERCENT OF A NUMBER (EASY)	20. FINDING EQUIVALENT FRACTIONS
21. DEC DIVIDED BY DEC	21. COMPARING FRACTIONS
22. DEC-%-FRAC CONVERSIONS (EASIER)	22. ADDING FRACTIONS
23. SCIENTIFIC NOTATION	23. SUBTRACTING FRACTIONS
24. FRAC & % CONVERSIONS (HARDER)	24. ADD/SUB MIXED NUMBERS
25. 'N IS M% OF ??' TYPE PROBLEMS	25. RATIOS
26. MULT & DIV DECIMAL WORD PROBS	26. DEC. CONCEPTS USING PLACE VALUE
27. FIND PERCENT OF A NUMBER (HARD)	27. CONVERSION FROM FRACS. TO DEC.
28. PERCENT WORD PROBS (EASY)	28. ADDING & SUBTRACTING DECIMALS
29. RATIO EQUATIONS	29. CUSTOMARY UNITS
30. SOLVE SIMPLE ALGEBRAIC EQUATIONS	30. METRIC UNITS
31. OPERATIONS ON NEGATIVE INTEGERS	31. GRAPHS-PICTO/BAR/LINE/COOR
32. PERCENT & RATIO WORD PROBS (HARD)	32. SIMPLE PROBABILITY
33. SQUARES & SQUARE ROOTS	33. WORD PROBLEMS - W.N. OPERATIONS
34. SURFACE AREA AND VOLUME	34. WORD PROBLEMS - FRAC/DEC/RATIO
35. METRIC UNITS	35. WORD PROBLEMS - MEASUREMENT
36. TRIANGLES	36.
37. QUADRILATERALS	37.
38. ANGLES	38.
39. BALANCE CHECKBOOK	39.
40. COORDINATE GRAPHS	40.
41. SET THEORY- INTERSECTION & UNION	41.
42. READING A TABLE	42.
43. COMPUTE AVERAGE OF A SET OF #'S	43.
44. STATISTICS- MEDIAN/MODE/MEAN	44.
45. CIRCLES- CIRCUMFERENCE & AREA	45.
46.	46.
47.	47.
48.	48.
49.	49.
50. STUDENT INSTRUCTIONS	50.

IMPAC LEARNING SYSTEMS

OBJECTIVE NAMES OF GRD5 ### OBJECTIVE NAME	OBJECTIVE NAMES OF GRD6 ### OBJECTIVE NAME
1. NUMERATION AND ORDER	1. W.N. CONCEPTS USING PLACE VALUE
2. W.N. CONCEPTS USING PLACE VALUE	2. ADDING WHOLE NUMBERS
3. NUMBER SENTENCES USING W.N.	3. SUBTRACTING WHOLE NUMBERS
4. EVEN AND ODD NUMBERS	4. MULTIPLYING WHOLE NUMBERS
5. OTHER NUMERATION SYSTEMS	5. DIVIDING WHOLE NUMBERS
6. FINITE AND INFINITE SETS	6. DIVISIBILITY
7. ADDITION CONCEPTS - W. NUMBERS	7. FACT.-PRIME/COMPOSITE/COMMON
8. APPLICATIONS WITH W.N. ADDITION	8. LEAST COMMON MULTIPLE
9. SUBTRACTION CONCEPTS - W. NUMBERS	9. INTRODUCTION TO FRACTIONS
10. APPLICATIONS WITH W.N. SUBT.	10. FINDING EQUIV. FRACTIONS
11. MULTIPLICATION CONCEPTS - W.N.	11. COMPARING FRACTIONS
12. APPLICATIONS WITH W.N. MULT.	12. SIMPLIFYING FRACTIONS
13. DIVISION CONCEPTS - W. NUMBERS	13. ADDING FRACTIONS
14. APPLICATIONS WITH W.N. DIVISION	14. SUBTRACTING FRACTIONS
15. BASIC GEOMETRIC FIGURES	15. RENAME FRAC & MIXED NUMERALS
16. FIGURES IN THE PLANE	16. ADDING MIXED NUMERALS
17. SOLIDS	17. SUBTRACTING MIXED NUMERALS
18. DIVISIBILITY	18. MULTIPLYING FRACTIONS
19. FACTORS - PRIME/COMPOSITE/COMMON	19. MULTIPLYING MIXED NUMERALS
20. GREATEST COMMON FACTOR	20. DIVIDING FRACTIONS
21. LEAST COMMON MULTIPLE	21. DIVIDING MIXED NUMERALS
22. INTRODUCTION TO FRACTIONS	22. DEC. CONCEPTS USING PLACE VALUE
23. FINDING EQUIVALENT FRACTIONS	23. ADD & SUB DECIMAL NUMBERS
24. SIMPLIFYING FRACTIONS	24. MULTIPLYING DECIMAL NUMBERS
25. ADDING FRACTIONS	25. DIVIDING DECIMAL NUMBERS
26. SUBTRACTING FRACTIONS	26. CONVERSIONS BETWEEN FRAC & DEC
27. ADDING/SUBTRACTING MIXED NUMBERS	27. RATIOS
28. MULTIPLYING & DIVIDING FRACTIONS	28. PROPORTIONS & PROBLEM SOLVING
29. RATIOS	29. INTRODUCTION TO PERCENT
30. DEC. CONCEPTS USING PLACE VALUE	30. CONVERSIONS FROM FRAC TO %
31. CONVERSION FROM FRACS. TO DEC.	31. PROB SOLVING-PROPORTIONS & %
32. ADDING & SUBTRACTING DECIMALS	32. COMPARING INTEGERS
33. MULTIPLYING DECIMALS	33. ADDING INTEGERS
34. DIVIDING DECIMALS	34. SUBTRACTING INTEGERS
35. FRACTION - % - DEC. CONVERSIONS	35. GRAPHING ON THE COOR PLANE
36. PERCENT AND PROBLEM SOLVING	36. FIGURES IN THE PLANE
37. CUSTOMARY UNITS	37. PERIMETERS/AREAS
38. METRIC UNITS	38. METRIC UNITS
39. GRAPHS - BAR/LINE/CIRCLE ETC.	39.
40. SIMPLE PROBABILITY	40.
41. SUMS & DIFFERENCES OF INTEGERS	41.
42. PRODUCTS & QUOTIENTS OF INTEGERS	42.
43. GRAPHING ORDERED PAIRS	43.
44. WORD PROBLEMS - W.N. OPERATIONS	44.
45. WORD PROBLEMS - RATIO/FRAC/DEC/%	45.
46. WORD PROBLEMS - MEASUREMENT	46.
47.	47.
48.	48.
49.	49.
50.	50.

IMPAC LEARNING SYSTEMS

OBJECTIVE NAMES OF GRD7 ### OBJECTIVE NAME	OBJECTIVE NAMES OF GRD8 ### OBJECTIVE NAME
1. NUMERATION AND ORDER OF W.N.	1. DEC. CONCEPTS USING PLACE VALUE
2. PROPERTIES OF WHOLE NUMBERS	2. ADDING & SUBTRACTING DECIMALS
3. EVALUATING EXPRESSIONS	3. MULTIPLYING DECIMALS
4. W.N. CONCEPTS USING PLACE VALUE	4. DIVIDING DECIMALS
5. WHOLE NUMBER OPERATIONS	5. WORD PROBLEMS USING DECIMALS
6. WHOLE NUMBER WORD PROBLEMS	6. RENAMING & SIMPLIFYING FRAC
7. SOLVE SIMPLE ALGEBRAIC EQUATIONS	7. ADDING FRACTIONS & MIXED #'S
8. DEC. CONCEPTS USING PLACE VALUE	8. SUBTRACTING FRACS & MIXED #'S
9. ADD & SUBT. DECIMAL NUMBERS	9. MULTIPLYING FRACS & MIXED #'S
10. MULTIPLYING DECIMAL NUMBERS	10. DIVIDING FRACS & MIXED #'S
11. DIVIDING DECIMAL NUMBERS	11. WORD PROBLEMS USING FRACTIONS
12. FACTORS - PRIME/COMPOSITE	12. RATIOS AND PROPORTIONS
13. DIVISIBILITY	13. INTRODUCTION TO %
14. GREATEST COMMON FACTOR	14. DECIMAL & % CONVERSIONS
15. LEAST COMMON MULTIPLE	15. FRACTION & % CONVERSIONS
16. INTRODUCTION TO FRACTIONS	16. PROBLEM SOLVING-PROPORTION & %
17. SIMPLIFYING FRACTIONS	17. SETS & SET NOTATION
18. FINDING EQUIVALENT FRACTIONS	18. VENN DIAGRAMS
19. MIXED AND IMPROPER CONVERSIONS	19. INTRO TO THE SET OF RATIONAL #'S
20. COMPARING FRACTIONS	20. ADD INTEGERS & RATIONAL #'S
21. ADD & SUBT. FRACTIONS (C.DENOM.)	21. SUB. INTEGERS & RATIONAL #'S
22. ADD & SUBT. FRACS. (NO C.DENOM.)	22. MULTIPLY INTEGERS & RATIONAL #'S
23. MULTIPLYING FRACTIONS	23. PROPERTIES OF RATIONAL #'S
24. DIVIDING FRACTIONS	24. DIVIDE INTEGERS & RATIONAL #'S
25. RATIOS	25. INTRODUCTION TO EXPONENTS
26. PROPORTIONS & PROBLEM SOLVING	26. LAWS OF EXPONENTS
27. FRACTION & DECIMAL CONVERSIONS	27. EXPONENTS & PLACE VALUE
28. DECIMAL & % CONVERSIONS	28. WRITE/EVALUATE PHRASES & SENT.
29. CONVERSIONS FROM % TO FRACTIONS	29. EQUIVALENT EQUATIONS
30. PROBLEM SOLVING - PROPORTION & %	30. SIMPLIFYING EXPRESSIONS
31. POINTS / SEGMENTS / RAYS	31. SOLVING EQUATIONS - 1 VARIABLE
32. LINES AND PLANES	32. SOLVING INEQUALITIES - 1 VARIABLE
33. ANGLES	33. SOLVE W. PROB. WITH EQUATIONS
34. POLYGONS	34. FEATURES OF RATIONAL #'S
35. CONGRUENT FIGURES	35. INTRODUCTION TO IRRATIONAL #'S
36. PERIMETER AND CIRCUMFERENCE	36. THE SET OF REAL NUMBERS
37. AREAS OF PLANE FIGURES	37. THE PYTHAGOREAN RELATIONSHIP
38. VOLUMES OF SOLIDS	38. SIMPLE & COMBINED PROBABILITY
39. INTRODUCTION TO INTEGERS	39. STATISTICAL MEASURES & GRAPHS
40. ADDING INTEGERS	40. SETS OF POINTS
41. SUBTRACTING INTEGERS	41. ANGLES
42. MULTIPLYING INTEGERS	42. POLYGONS & CIRCLES
43. DIVIDING INTEGERS	43. PERIMETER OF POLYGONS
44.	44. AREA OF POLYGONS & CIRCLES
45.	45. VOLUME & SURFACE AREA OF SOLIDS
46.	46. SOLVE EQUAT. & INEQUAL.-2 VAR.
47.	47. GRAPH EQUAT. & INEQUAL. - 2VAR.
48.	48. CUSTOMARY UNITS
49.	49. METRIC UNITS
50.	50. GLOSSARY

IMPAC LEARNING SYSTEMS

OBJECTIVE NAMES OF ALGEBRA I ### OBJECTIVE NAME	OBJECTIVE NAMES OF WORD PERCEPTION ###OBJECTIVE NAME
1. NUMBER EXPRESSIONS & STATEMENTS	1. USING SIGHT WORDS
2. ORDERED POINTS ON A # LINE	2. CONTEXT CLUES
3. SETS OF NUMBERS	3. INITIAL CONSONANTS
4. VARIABLES & MATH. EXPRESSIONS	4. FINAL CONSONANTS
5. OPEN EXPRESSIONS & SENTENCES	5. LONG VOWEL VOCABULARY
6. PROPERTIES OF REAL NUMBERS	6. SHORT VOWEL VOCABULARY
7. ADDING REAL NUMBERS	7. SINGLE VOWELS
8. MULTIPLYING REAL NUMBERS	8. C AND G SOUNDS
9. ADDITION PROPERTY OF EQUALITY	9. VOWEL COMBINATIONS
10. SUBTRACT & DIVIDE REAL #'S	10. SYLLABLES
11. MULTIPLICATION PROP. OF EQUALITY	11. SUFFIXES, PLURALS
12. SOLVE EQUATIONS - MULTIPLE STEPS	12. LONG AND SHORT U SOUNDS
13. PLAN FOR SOLVING WORD PROBLEMS	13. R AND L BLENDS
14. SOLVING INEQUALITIES	14. COMPOUND WORDS
15. COMBINING/GRAPHING INEQUALITIES	15. S BLENDS
16. W. PROBLEMS - MOTION/MIXTURE/AGE	16. Y ENDINGS
17. INTRODUCTION TO POLYNOMIALS	17. CONTRACTIONS
18. ADDING & SUBTRACTING POLYNOMIALS	18. EA AND OO
19. MULTIPLYING POLYNOMIALS	19. COUNT SYLLABLES
20. DIVIDING POLYNOMIALS	20. OU AND OW SOUNDS
21. SOLVE W. PROBLEMS - POLYNOMIALS	21. H AND K DIAGRAPHS
22. FACTORING-DISTRIBUTIVE PROPERTY	22. OI AND OU AND OW SOUNDS
23. FACTORING BINOMIALS	23. COMPOUND WORDS
24. FACTORING TRINOMIALS	24. KN, WR, PH, MB COMBINATIONS
25. APPLICATIONS OF FACTORING	25. PREFIXES
26. DEFINE & SIMPLIFY FRACTIONS	26. BREAK SYLLABLES
27. MULTIPLY & DIVIDE FRACTIONS	27. SUFFIXES
28. ADD & SUBT. ALGEBRAIC FRACTIONS	28. PLURALS
29. SIMPLIFY MIXED/COMPLEX FRACTIONS	29. VOWELS WITH R
30. EQUATIONS - REAL # DENOMINATOR	30. SUFFIXES AND ROOT WORDS
31. EQUATIONS - VARIABLES IN DENOM.	31. REVIEW OF BLENDS
32. GRAPHING RELATIONS & FUNCTIONS	32. REVIEW OF VOWEL SOUNDS
33. WRITE/GRAPH LINEAR EQUATIONS	33. PREFIX AND SUFFIX
34. SOLVE SYSTEMS - LINEAR EQUATIONS	34. POSSESSIVES
35. SOLVE W. PROBLEMS IN 2 VARIABLES	35. BREAK SYLLABLES (HARD)
36. SOLVE INEQUALITIES - 2 VARIABLES	36. CONTRACTIONS
37. RATIONAL NUMBERS	37. PAST TENSE AND PARTICIPLE
38. IRRATIONAL NUMBERS	38. ABBREVIATIONS
39. RADICALS	39.
40. OPERATIONS WITH RADICALS	40.
41. SOLVING RADICAL EQUATIONS	41.
42. SOLVING QUADRATIC EQUATIONS	42.
43. GLOSSARY	43.
44.	44.
45.	45.
46.	46.
47.	47.
48.	48.
49.	49.
50.	50.

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OBJECTIVE NAMES OF SCIENCE

OBJECTIVE NAME

1. THE THREE STATES OF MATTER
2. OUR SOLAR SYSTEM
3. WORK AND MACHINES
4. THE SURFACE OF THE EARTH
5. PLANTS: BASIC STRUCTURE
6. VERTEBRATES AND INVERTEBRATES
7. THE CHANGING STATE OF MATTER
8. THE UNIVERSE: THE MOON
9. MAGNETS AND ELECTRICITY
10. CHANGES IN SURFACE OF THE EARTH
11. PLANTS: REPRODUCTION
12. SYSTEMS OF THE HUMAN BODY
13. THE BUILDING BLOCKS OF MATTER
14. THE UNIVERSE: THE STARS
15. HEAT, LIGHT AND SOUND
16. THE EARTH: WEATHER
17. PHOTOSYNTHESIS
18. MORE SYSTEMS OF THE HUMAN BODY
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APPENDIX C

Table of ES Values
Elementary School Grades

(Comparisons subject to extreme deviations unless instructional conditions are similar to those in the underlying studies.)

Supplementary CAI/CMI/CMI-CAI	ES	Percentile (50% control group)
Elementary level overall achievement	.40	66%
Elementary level achievement-- Reading/Language Arts	.20 - .35	58 - 64%
Elementary level achievement-- Mathematics	35 - .45	64 - 67%
Student attitudes toward computers	.62	73%
Student attitudes toward instruction in the subject	.12 - .19	55 - 58%
Retention	.17	57%
CAI alone	.40 - .47	66 - 68%
CMI alone	.07 - .14	53 - 56%
CMI-CAI	.40 - .50	66 - 69%
Reducing Class Size: 25 to 20	.05	52%
25 to 15	.15	56%
25 to 10	.25	60%
Peer and cross-age remedial tutoring	.40	66%
Special inservice teacher training programs	.50	69%
Replacement CMI-CAI Elementary level mathematics	.22	59%
Elementary level reading/lang. arts	.15 - .17	56 - 57%

APPENDIX D
Identification of Instructional Processes

Instructional Management

Procedures	Rules	Assignments
Signals and Clues	Expectations	Establishing credibility with students
Monitoring Activities	Evaluation	Orientation to student goals
Observing learning patterns	Directing student traffic	Learning analysis of feed back
Aligning of content	Interpreting	Knowledge of subject objectives
Prescriptions	Reports	Regulating Environment

ON-TASK ACTIVITIES

Lecture	Goal Setting
Group Work	Worksheets
Periods of Incubation	Media
CAI	Motivation
Individualized Instruction	Feed Back
Peer Group Tutoring	Testing
Reinforcement	Field Trips

OFF-TASK ACTIVITIES

Disruptive Behavior

Transition Time

Outside Interruptions

Dead Time

Recess

Lunch

APPENDIX E
SCHEDULING

I. INSTRUCTIONAL BLOCKS OF TIME

A. Full Class Instruction

B. Small Group Instruction

C. Individual/Independent Work

II. COMPUTER TIME

A. CAI Instead of Individual Work

B. Increased Time on Task

Teachers schedule students for CAI activities as a substitute for textbook assignments, worksheets, learning centers, etc. During these activities, students work at the computers for approximately twenty minutes. This is usually sufficient time to work through one to three objectives involving several lessons.

Each student is expected to receive CAI four days out of ten in each of the two subject areas. Therefore, a student is working on the computer just about every other day in either reading/language arts or mathematics. This time can be counted as part of the recommended time for each subject area according to state suggested time allotment schedule.

EXAMPLE:

250 minutes	Full class, small group instruction
50 minutes	CAI activities (2-25 minute sessions)
300 minutes	Recommended time allotment for mathematics per week

APPENDIX F
TYPES AND USES COURSEWARE

I. TYPES OF COURSEWARE

A. CAI - Comprehensive with scope and sequence

1. Tutorial
   a. States a rule, presents information, provides examples and presents algorithms
   b. Reinforces regular instruction by reviewing the important concepts

2. Interactive
   a. Student fills in a word or phrase, chooses an answer or works a problem
   b. Provides positive feedback to the student through hints or by generating appropriate problems
   c. Verifies status of answer and redirects student work

3. Branching
   a. Guides a student through lessons depending on performance
   b. Can be teacher, student or computer initiated

4. Testing
   a. Checks mastery of courseware lesson or objective
   b. Checks performance on sets of skills (state basic skills, district goals or teacher objectives) which usually form a unit of instruction

B. CMI/CAI Management and Instruction

1. Records progress in each course by objective and lesson

2. Provides five progress reports appropriate for monitoring student progress,targeting areas of weakness and placing students into a sequence of lessons

II. Uses of courseware

A. To reinforce classroom instruction

B. To remediate non-mastered skills

C. To review for tests

APPENDIX G
SUMMARY OF IMPAC RESEARCH

An effective instructional program is influenced by certain general characteristics of the school:

1. The principal is a strong leader in the area of instruction.
2. The school climate promotes learning.
3. There are realistic expectations of students' achievement.

CMI-CAI offers some specific elements that facilitate an effective instructional program.

1. CMI assists in identifying and targeting objectives for mastery.
2. CMI may contribute to 15-20% of the gains under CMI-CAI.
3. Extra gains of 2-3 months (9% to 13%) may be achieved by adding CAI or CMI-CAI to regular instruction.
4. Supplementary CAI results in greater gains than replacement CAI.
5. CAI saves time and is associated with good retention.
6. Reading and language arts gains are usually about 70% of those made in mathematics.
7. High standards for electrical power are necessary in keeping the system "up".
8. It is important to develop a maintenance support system through a key operator or a laboratory manager.

In addition, gains in basic skills scores are affected in IMPAC schools through the following strategies:

1. Objectives included in the courseware are a 60-80% match with those covered by standardized tests and basic skills objectives list.
2. CAI is used on a 20% / 80% ratio to regular instruction.
3. CAI is presented during 20-25 minute sessions two days out of five per subject.
4. A student works in only two subjects at a given time.
5. In self-contained classrooms teachers provide total management.
6. In a laboratory the lab manager provides technical management; the teacher provides instructional management.

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