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ABSTRACT

This paper presents the final report of a project designed to produce an effective individualized adult learning program in mathematics. The need for such a project has been reflected in the reports of national commissions and studies which provided documentation and statistics on the lack of proficiency of adults and young adults in the basic skills of mathematics. The purpose of this project was to convert to a computer-assisted format an existing program, "Individualized Learning for Adults (ILA)--Mathematics." Five objectives were involved in the effort: (1) to revise the ILA Mathematics curriculum content; (2) to revise the ILA testing and diagnostic measures; (3) to computerize the revised ILA curriculum content; (4) to computerize the revised testing and diagnostic measures; and (5) to disseminate/evaluate the new ILA/CAI math curriculum. The introduction to the report presents the problem and need which led to the project as well as the procedures and strategies used in carrying it out. A section on accomplishments then reviews each of the project objectives together with the procedures used to achieve the individual objectives and the accomplishments realized for each objective. The final section presents conclusions and recommendations. Findings indicated that four of the objectives of the original plan were achieved, while objective five was only partially met. (JLB)

COMPUTER ASSISTED ADULT EDUCATION

MATH SERIES

A Final Report

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Copies of this report may be obtained by contacting: Dr. Russell A. Dewicz, Research for Better Schools, 444 North Third Street, Philadelphia, PA 19123

ABSTRACT

This paper represents a year-end final report for the project entitled "Computer Assisted Adult Education: Math Series." The project was funded during the period from July 1, 1984 through June 30, 1985, through a grant from the Pennsylvania Department of Education (#98-5004) and the U.S. Department of Education. The need for the project has been reflected in the reports of recent national commissions and national studies which have provided considerable documentation and rather sobering statistics concerning the lack of proficiency of adults and near adults in the basic skills of mathematics and reading.

The purpose of the project was to convert to a computer assisted format an already successful and existing program entitled "Individualized Learning for Adults (ILA)-Mathematics." This program was first developed as an adult mathematics curriculum that consisted of a carefully structured continuum of skills designed to lead the learner to an approximate ninth grade mathematics skill level. It was developed by Research for Better Schools and has been in use by a number of agencies for adult and young adult learners whose functional level in mathematics skills is below ninth grade.

Five objectives were involved in the effort to convert ILA to a computer assisted instruction (CAI) format. These objectives were:

- to revise the ILA Mathematics curriculum content
- to revise the ILA testing and diagnostic measures
- to computerize the revised ILA curriculum content
- to computerize the revised testing and diagnostic measures
- to disseminate/evaluate the new ILA/CAI math curriculum.

In accordance with the above objectives, the existing hard copy ILA math curriculum and testing package were revised. Particular attention was devoted during the revision to modifying the graphics, making the text more appropriate for the computer assisted format, and increasing the amount of tutorial narrative. Software was developed around the revised system to provide an appropriate microcomputer based mathematics program.

It is anticipated that the work embodied in this report, as well as the math curriculum program itself, will prove to be of most use to local adult basic education programs, libraries, individual educators, and institutional education programs.

INTRODUCTION AND OVERVIEW

The project entitled "Computer Assisted Adult Education: Math Series" was funded from July 1, 1984 through June 30, 1985 through a grant (#98-5004) awarded to Research for Better Schools (RBS) by the Pennsylvania Department of Education in cooperation with the U.S. Department of Education.

The goal of this project was to produce an effective individualized adult learning program in mathematics to address the growing need for instruction in the basic skills for adults and young adults. This need has been most recently documented in national commission reports and national studies which have shown substantial lack of proficiency in basic reading and math skills among these segments of the population. The manner in which the project goal was to be accomplished was to make use of the latest advances in computer technology to computerize an already existing and successful individualized mathematics program for adults. The program that was selected was the mathematics portion of the "Individualized Learning for Adults (ILA)" program developed originally by Research for Better Schools. The work of this project consisted principally of revising the ILA math program and converting it to a computer assisted format. Due to its extensive installed user base in education, the Apple computer was selected for use with the new computer assisted program.

The revision, conversion, and programming involved in this effort was extensive. RBS staff who were instrumental in successfully producing the new program included: Dr. Russell A. Dusewicz, Project Director; Marge Connelly, Programming Coordinator; John Knorr, Programmer; Larry Bullock,

Programmer; and David Snelbecker, Programmer. Also assisting in the programming were a number of part-time staff who contributed in various degrees to the successful completion of this effort.

Both this report and the program that was developed are aimed primarily at local adult basic education programs, adult learning centers, libraries, secondary compensatory education programs, institutional education settings at the secondary level for adults, and individual educators.

Copies of this report have been forwarded to the Division of Adult Education at the Pennsylvania Department of Education, the U.S. Department of Education, and the ERIC system. A limited number of copies are also available by request from Research for Better Schools. At RBS, information on the computerized ILA math program, its instructional manual, and diskettes, may be obtained by contacting: Dr. Russell A. Dusewicz, Evaluation Services, Research for Better Schools, 444 North Third Street, Philadelphia, PA 19123.

The balance of this introductory section of the report will describe the problem and need which led to proposing and carrying out of this project, the goals and objectives addressed by the project, and the procedures and strategies used in carrying out the project. Following the introduction, a section on accomplishments will detail how each objective of the program was addressed during the course of the project and what products or accomplishments resulted. Finally, a section on conclusions and recommendations will delineate the products produced as a result of this project's effort, their anticipated use, and the overall significance of the work.

Problem and Need

The Adult Performance Level survey of "functional competencies," the National Commission on Excellence report entitled A Nation at Risk, and other national studies have offered some rather sobering statistics concerning the proficiency of adults and near-adults in the basic skills. Over 30 million adults are functionally illiterate in the areas of everyday reading, writing and problem-solving. An estimated 40 million adults cannot interpret an earnings statement well enough to find the deduction for social security. Over 50 million adults cannot determine the correct amount of change from a purchase when given a cash receipt and the denomination of the bill used to pay for the purchase. About 40% of near-adults cannot draw inferences from simple written material, only 1/5 can write a simple essay, and only 1/3 can solve math problems requiring several simple steps. Remedial math courses in public four-year colleges increased by 72% between 1975 and 1980 and now represent about 1/4 of all math courses taught in such institutions. A recent Department of the Navy report indicated that 1/4 of all incoming recruits cannot read at the minimal level needed to understand simple written safety instructions, and without remedial work cannot even begin the more sophisticated training essential to maintaining the modern military system. Since these basic skills are essential in everyday living, getting and maintaining a job, handling personal finances, understanding health and safety notices, and voting, problems in this area have serious social and economic consequences.

A new and innovative trend, gaining in popularity, is the application of computer assisted instruction applied to adult basic education. Its use

overcomes many of the obstacles encountered in the education of adults. It is individualized, self-pacing, and can be accessed at times outside of traditional class scheduling. While the costs of providing instruction using this kind of technology are still rather high, the accelerated decline in such costs will make such computer system instruction commonplace within only a few years. Presently there exists a dearth of basic skills programs, designed specifically for adults, which are available in a computer assisted instructional mode. The few packages that are available of this type are either borrowed from elementary and secondary education programs and applied at the adult level, or are available only by terminal using a high-cost time-sharing system tied to a mainframe computer. With the popularization and the relatively low cost of microcomputers, this situation should be changing rapidly.

In keeping with the new trend toward use of microcomputers in adult basic education, RBS initiated the present project, through Adult Education 310 funding, to computerize its previously successful Individualized Learning for Adults program, and to make it available, at cost, to local Pennsylvania ABE programs, libraries, and schools.

Goals and Objectives

The overall goal of the project was to computerize the math component of the ILA curriculum, as reflected in the following objectives.

- revise the ILA mathematics curriculum content
- revise the ILA testing and diagnostic measures
- computerize the revised ILA curriculum content
- computerize the revised testing and diagnostic measures
- disseminate/evaluate the new ILA/CAI math curriculum.

The objectives listed above directly addressed the 1984-85 Pennsylvania adult education state priority of developing procedures and a curriculum in mathematics and the software necessary for computer assisted instruction.

The general approach used in carrying out these objectives for the current project focused upon the following steps.

- Initial planning and specification of detailed workscope for the project.
- Selection of the microcomputer and operating system for which the CAI package was to be developed.
- Revision of the ILA math curriculum materials for all levels and areas, with special attention to improvement of the graphics and the addition of tutorials.
- Revision of the ILA testing and diagnostic materials.
- Programming all software necessary for the computer assisted instruction package using revised ILA curriculum materials.
- Programming all software necessary for developing the computer assisted testing and diagnostic package.
- Reporting on progress and products to PDE and other agencies.
- Dissemination of awareness information on the availability of the new computer assisted instruction ABE program.

The Program

In addressing the above goal and objectives of the project, a new computer assisted ILA program was developed. This new ILA mathematics program is designed to be a complete system of individualized instruction in mathematic skills typically found up to the ninth grade level. However, activities and lessons are presented in a format suitable for adults. The ILA program also has several key features which make it especially suitable for use with a wide diversity of adult students.

- Individualized - Immediate feedback is provided for each student based on his or her responses. Learners are helped to select the pathway through the material which is most appropriate for their needs.

- Modular in structure - Instruction is presented in small, well-defined units which are less intimidating to students than large blocks of material.

- Objective based - The competencies which the students are expected to acquire are defined in terms of specific learning outcomes called objectives. Students begin with the simplest objectives and progress to the most complex; this approach minimizes student frustration and allows students to measure their own success and progress.

- Based on the mastery learning model - Each objective must be completely mastered by a student according to a specified criterion before he or she can continue to the next objective in the structure. This model minimizes student frustration and enhances learner success because efficient use is made of the student's time.

- Diagnostic and prescriptive - Each incoming student is assessed to identify skill deficiencies. This information is used to place each student appropriately within the curriculum and to direct learners to the instructional materials most appropriate to their needs.

The ILA content areas are defined from a continuum of performance objectives, or competencies, which lead the learner through prescribed learning activities until mastery is achieved. The evaluative and diagnostic testing as well as the recordkeeping of student performance are integral to the system.

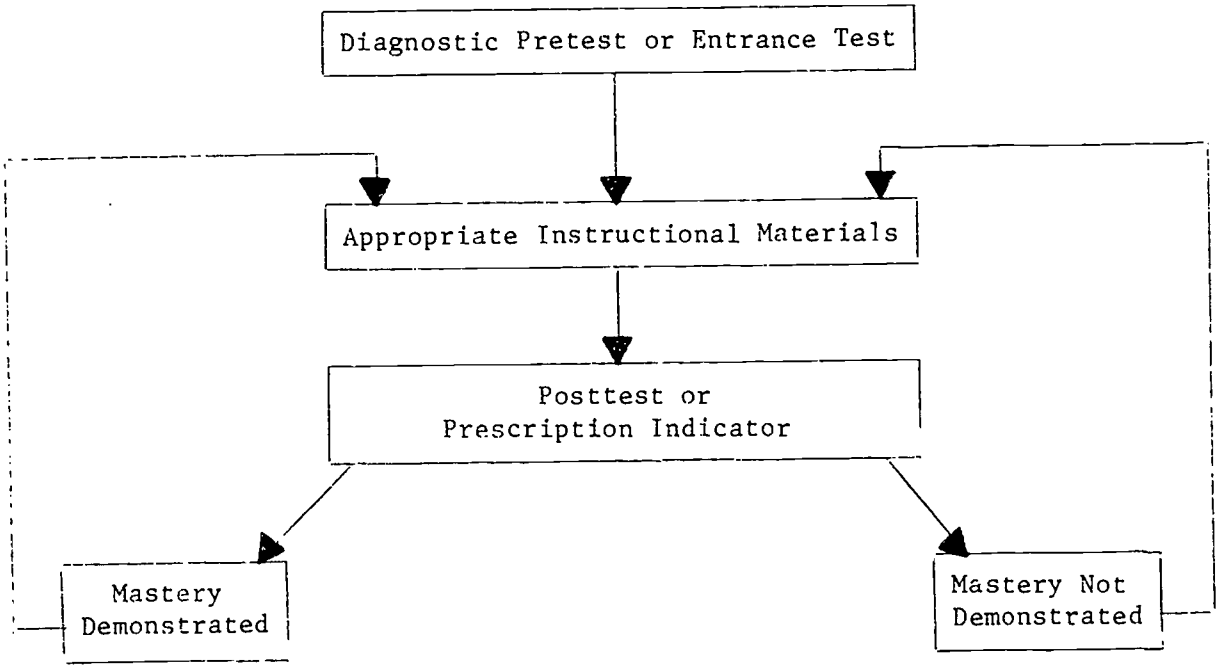
In the ILA instructional system, each learning task is specified by performance objectives and placed in sequence from easiest to most difficult. Tasks are then clustered. Each cluster is considered as a level and identified by a letter of the alphabet, A through H. Two types of criterion referenced tests are used. A diagnostic test, taken initially by each student covering all of the content areas, gives a rough estimate of the level at which the student is able to function with 80% accuracy. Posttests, or Prescription Indicators, are used in assessing performance levels within each of the skill clusters. Two forms of each posttest assess student performance in each instructional unit. If the student is unable to respond with 80% accuracy to the test items for any unit, he or she is presumed to need further instruction in that unit, and is recycled through the instructional lessons.

Generally, one instructional lesson is available for each performance objective. Lessons are largely self-instructional. Each student works only in lessons for which there is a demonstrated need. The learning of each student is monitored and directed through a Student Profile. Learning prescriptions are monitored by the computer, and reviewed in turn by the teacher.

Upon entering the program, each student takes the diagnostic test and receives a Student Profile. On it is recorded his or her status at

entrance and the date on which each unit is mastered. Mastery is achieved when the student completes the items on the appropriate posttest or Prescription Indicator with 80% or greater accuracy. The student works systematically, mastering each easiest placed unit until mastery of all areas of the ILA mathematics program is demonstrated.

The diagram that follows summarizes the sequence of instruction in the new computer assisted ILA program.



ACCOMPLISHMENTS

In this section, each objective of the project is reviewed, together with the procedures employed to achieve that objective, and the accomplishments realized with respect to that objective.

Revising Curriculum and Tests

The first and second objectives relate to revision of the ILA math curriculum (to improve the graphics and tutorials) and of the ILA math testing and diagnostics.

Before describing accomplishments in this area, it would be informative to briefly review the pre-project structure of the ILA math curriculum in order to better understand the changes or revisions which were made.

The ILA mathematics curriculum had five specific content areas as follows: numeration-place value, addition-subtraction, multiplication-division, geometry-measurement, and applications. This curriculum included over 3,000 pages of tests, lesson booklets, and answer keys. It was an extensive curriculum package requiring considerable redesign and programming efforts.

The typical student would take a diagnostic test upon entrance to the program. Following this test, the student would be placed in a particular level and referred to a specific lesson within that level. The student would then take a pretest, work through the lessons, and then take a posttest to check on mastery. Depending upon the results of that posttest, the student would either be recycled through the same lesson or would be moved on to another prescribed lesson.

In revising the ILA curriculum and testing, the following major problems had to be overcome.

- The program was originally developed in 1972 and some of the material (especially in the geometry-measurement and applications areas) was out-of-date.
- There was a distinct lack of tutorial material within the lessons.
- Graphics utilized in the materials were unsuitable for use with a computerized version due to a lack of quality and difference in content.
- The curriculum was characterized by so much testing that it was feared this would lower motivation for the adult student.

In addressing this latter problem, it was decided to eliminate all pretests for each of the lessons. This meant that the student could immediately proceed to lesson material following his or her initial diagnostic testing. While the original pretest for each lesson may have served as a useful check on the accuracy of the diagnostic test, it was felt that this acted more as a motivational detriment to the program.

Therefore, in the present system, students simply take a diagnostic test and are referred or placed in the lessons based on the results of the diagnostic test. They then proceed to work through the lesson material. Following completion of each lesson they are administered a posttest, which then determines whether their mastery is sufficient to continue on to the next lesson. Should they be recycled through the same lesson material as a result of insufficient mastery, a different posttest is administered at the end of the recycled lesson.

In order to improve the quality of the graphics within the ILA material and the lack of sufficient tutorials, major revisions were undertaken. The graphics were revised and substantial tutorials were added to supplement the existing lesson contents.

The applications section was eliminated entirely and only limited portions of the geometry-measurement section was included and incorporated in the initial three sections. These initial three sections constituted the bulk of the lessons, in any case. It was felt that, for more advanced students, teachers could provide supplementary materials which were more up-to-date in these areas.

To aid in teacher management of the system, special programs were written to tie together the diagnostic test and posttest results in a central student profile which can be viewed by the teacher and student alike. This profile is adjusted and updated on the basis of the most recent test information secured from each of the posttests.

Computerizing Revised Curriculum and Tests

The third and fourth objectives relate to the development of the computer assisted package by programming the revised curriculum materials and testing materials.

The first step in programming the curriculum and testing package was the selection of the computer, the operating system, and the programming language to be used. These were all important decisions to be made during the initial stages of the project. A state-wide survey of local adult education programs in a neighboring state found that the most commonly used computers at program sites were the Apple IIe and Radio Shack's TRS-80, Model III. Several options immediately became apparent. The CAI math package could be written in Apple Basic to run under Apple DOS (Disk Operating System) or written in Radio Shack Basic to operate under TRS-DOS. The third option would be to program the CAI/ILA package in C-Basic and make it available under the popular CPM operating system with which an

increasing number of computers are offering compatibility. The IBM-PC was not a major consideration in this decision because it had not as yet found its way into adult education programs in substantial numbers, nor in the educational arena in general. Still a fourth option was to utilize a CAI authoring program specific to one of the operating systems already indicated. In the end, because of the rather substantial installed base of Apple IIe computers within the education field, the decision was reached to use the Apple II series of computer as the basis for the program. In order to make the programming more appropriate for use with Apple II + and IIe computers, the typical Apple DOS operating system was used and programming was done in Apple Basic.

The actual programming of both curriculum and testing materials followed a deliberate and structured approach. The programming was guided by preplanned flow charts and used a graphics package. The appearance and workability of the original ILA was improved greatly during revision. Advanced graphics capabilities, including animation, were used where possible and appropriate. All programs were made available on floppy diskettes and the final version assumes the availability of a dual disk drive for an Apple II + or IIe system.

As stated earlier, the extensiveness of the program revision and programming effort cannot be overstated. The timeline for completion of the project, given the level of effort, was very tight, indeed. Any problems which would produce a delay in either the revision or programming effort would inevitably produce a major problem in completing the project on time.

While revisions to the curriculum materials and testing materials proceeded generally on schedule, the changes needed to adapt the graphics to

the computer-assisted version produced some delays. Of more serious consequence, however, was a four-month delay in getting the enhancements advertised for the computer. This created a major problem for the vendors, who had guaranteed the product would work, and a serious delay in the programming aspect of the project.

Dissemination/Evaluation of the New Program

The fifth objective relates to the dissemination and evaluation of the new program. Products of the project's workscope consist of a CAI/ILA package for mathematics instruction together with an accompanying manual and this final report. Limited dissemination of information about this project and its resultant products has been accomplished through periodic progress reports to PDE. With the submission of this evaluation report, distribution of project information will be made to ABE programs across the state, and, as requests for information are received, to programs in other states. In addition, presentations on the project will be made at conferences and meetings as appropriate.

In terms of evaluation, the initial plan was each lesson to be evaluated by an independent professional at RBS who was not part of the team of developers. In addition, an external panel of evaluative reviewers was to be assembled to review the final version of the curriculum and testing package, but due to the delays experienced in programming the curriculum, this was not possible. As it was, the final product was substantially delayed in completion. Nevertheless, at least one external site has agreed to pilot test the curriculum and testing package with students and to evaluate and provide feedback. It is believed that this will provide a

realistic and meaningful evaluation. It should be noted, however, that it is the computerized version of the ILA math program that is to be pilot tested and not the original math program itself. The original math program already demonstrated its success through testing with over 700 students during the time it was under development. It is anticipated that results with students on the computerized version of this program will be equally successful and that the primary feedback from the pilot testing will deal with minor modifications and revisions in the mechanics of how the program works and is carried out on the computer.

CONCLUSIONS AND RECOMMENDATIONS

Overall, the "Computer-Assisted Adult Education: Math Series" project was successful in producing a computerized version of the ILA math program. In addition to this description of the development process for the new program, two additional documents are available. These are: "ILA Mathematics: A Users Manual for the Computer Program," and "ILA Mathematics: Catalogue of Materials." The new program contains improved graphics and tutorials. It should be a useful addition to any adult basic education program which has available to it Apple II computers.

While the final computer package and accompanying manual are believed to be quality products, it cannot be said that 11 of the objectives for the project were completed as originally planned. The objective concerning dissemination and evaluation of the new curriculum was only partially completed within the time frame of the project. Although evaluation data are available on the original version of the ILA math curriculum, and arrangements have been made to produce evaluation data on the computerized version in the future, no evaluation information of an external nature can be included with this report due to the rather late completion of the curriculum product. Ongoing evaluation of the curriculum was undertaken during developmentby RBS staff, and valuable feedback was provided to the development team in producing revisions and in debugging some of the programming.

In conclusion, it may be observed that the first four objectives of the original program plan were achieved, while objective five was only partially achieved.

Due to the current need for individualized methods of instruction in adult education, and a lack of appropriate basic skills programs to take advantage of the more recent advances in technology in the education field, it is recommended that adult education programs make use of the computer-assisted instructional products produced in this project and similar projects in the conduct of adult basic education programs. The use of such computer-assisted instructional programs can serve to enhance even further the individualization of programs at the local level. In this way, teachers can be freed from more mundane instructional chores to focus on the more difficult concepts and individual problems students experience in dealing with different aspects of the math curriculum. It is in these instances that a one-to-one individualized tutorial relationship between teacher and student can be employed and experienced to its maximum.