# DOCUMENT RESUME

ED 076 042 EM 011 041

| | |
|---|---|
| AUTHOR | Hall, Keith A.; And Others |
| TITLE | Inservice Mathematics Education for Elementary School Teachers Via Computer-Assisted Instruction (Gladeville). Interim Report. |
| INSTITUTION | Pennsylvania State Univ., University Park. Computer-Assisted Instruction Lab. |
| SPONS AGENCY | Appalachia Educational Lab., Charleston, W. Va. |
| REPORT NO | PSU-CAI-R-22 |
| PUB DATE | 8 Aug 69 |
| NOTE | 72p. |
| EDRS PRICE | MF-$0.65 HC-$3.29 |
| DESCRIPTORS | *Computer Assisted Instruction; *Elementary Grades; Field Studies; *Inservice Teacher Education; *Mathematics Education; Mathematics Instruction; *Mobile Classrooms; Modern Mathematics; Rural Education |


ABSTRACT

A second field test of a computer-based, mobile, in-service teacher education program in modern mathematics for elementary school teachers is reported here. Evaluations of the students' achievement and of their attitudes towards mathematics and computer-assisted instruction, as well as an analysis of the relationships among achievement, attitudes, and time devoted to studying with computer-assisted instruction are presented. A description of the curriculum revisions and the computer system operation are also provided. (EM 011 037 through EM 011 043, EM 011 046, EM 011 047, and EM 011 049 through EM 011 058 are related documents.) (RH)

C·A·I

# COMPUTER ASSISTED INSTRUCTION LABORATORY

COLLEGE OF EDUCATION · CHAMBERS BUILDING

THE PENNSYLVANIA STATE UNIVERSITY · UNIVERSITY PARK, PA.

# INSERVICE MATHEMATICS EDUCATION FOR ELEMENTARY SCHOOL TEACHERS VIA COMPUTER-ASSISTED INSTRUCTION

INTERIM REPORT

AUGUST 8, 1969

Report No. R-22

Note to accompany the Penn State Documents.

In order to have the entire collection of reports generated by the Computer Assisted Instruction Lab. at Penn State University included in the ERIC archives, the ERIC Clearinghouse on Educational Media and Technology was asked by Penn State to input the material. We are therefore including some documents which may be several years old. Also, so that our bibliographic information will conform with Penn State's, we have occasionally changed the title somewhat, or added information that may not be on the title page. Two of the documents in the CARE (Computer Assisted Remedial Education) collection were transferred to ERIC/EC to abstract. They are Report Number R-36 and Report Number R-50.

— Jacklyn Caselli, ERIC/EM

ED 076042

The Pennsylvania State University

Computer Assisted Instruction Laboratory
University Park, Pennsylvania

# INSERVICE MATHEMATICS EDUCATION FOR ELEMENTARY SCHOOL TEACHERS VIA COMPUTER-ASSISTED INSTRUCTION

Gladeville, Virginia

Sponsored by

The Appalachia Educational Laboratory, Inc.
Charleston, West Virginia



Principal Investigator

Keith A. Hall

Associate Investigators

Harold E. Mitzel — Marilyn N. Suydam
C. Alan Riedesel — Cecil R. Trueblood
Stanley W. Mechlin

Interim Report
August 8, 1969

Report No. R-22

## ACKNOWLEDGMENTS

Recognition must go to a number of people who have been actively working and lending their support to this inservice education project: Mr. Joseph Berry, Federal Programs Coordinator for Carroll County, Virginia, and Mr. John Cooper, Science Supervisor for the County School, who coordinated the activities at the setting in Gladeville, Virginia, by arranging for physical facilities as well as coordinating with the other school administrators; to Mr. Charles Smythers must go our apology for creating confusion and litter in a model school and our thanks to him for making our stay so pleasant. Special recognition must also go to the IBM Corporation for making the demonstration possible, to Mr. William Murdock, the IBM Field Engineering Manager, at Roanoke, and to Mr. Daniel Smith the IBM Customer Engineer at Radford who provided the maintenance and engineering support for the system.

Dedicated and enthusiastic support of the system operation was provided by Mrs. Ann Cooper, Mrs. Mary Lou Truett, and Mrs. Mary Nobelett.

Recognition must also go to Mr. Don Simcisko, Mrs. Diane Knull, Mrs. Darlene Smith, Mrs. Leslye Bloom, Mrs. Kris Sefchick and Mrs. Barbara Lippincott of the CAI Laboratory at University Park, for their supportive efforts in developing materials, reproducing student materials, and budget management on the project.

PREFACE

Gladeville is a small community in Carroll County, Virginia, about three miles east of Galax and near the North Carolina border. Its modern elementary school was the site of the second setting for the computer-based, mobile, inservice teacher education program sponsored by the Appalachia Educational Laboratory of Charleston, West Virginia, in cooperation with The Pennsylvania State University, the Virginia State Department of Education, and the International Business Machines Corporation. An earlier seven-week experience in March and April of this year was conducted at Dryden, Virginia (Lee County), and a report (Computer Assisted Instruction Laboratory, The Pennsylvania State University, R-19) was prepared by the authors of the present document. Currently, a third seven-week experience with the same course and format is underway at California, Pennsylvania. A consolidated report summarizing the experiences and the products of the three settings will be available by the end of 1969.

Many educators have heard that there is such a phenomenon as computer-assisted instruction, but most are unaware that the technique is beyond the developmental or laboratory stage and is ready for limited operational use in carefully selected situations. One such educational situation for which there is an urgent need is the retraining and upgrading of teachers who are currently in service. Because teachers frequently find it impossible for personal reasons to return to college campuses, the re education they need should be taken to them. This solution to the problem of inservice education gave rise to the "extension class," which has enjoyed widespread application during the past four decades. It is, however, getting more and more difficult to staff these field courses with qualified instructors. Hence, the whole field of continuing education is ripe for a technological innovation that will bring quality instruction to practitioners in the field. At the close of the present cycle of three computer-based instructional settings in modern mathematics on August 31, 1969, we will have provided a two-credit college course to more than four hundred educators. This report and the previous one based on the Dryden experience both show that the computer-assisted instruction technique is successful. The students, many of whom thought that they were through with learning activities, show growth in knowledge and a high degree of enthusiasm for the individualized technique to which they were exposed.

Although a great deal remains to be done that will improve the operation of a mobile computer-based instruction unit in the field, we believe that we have demonstrated the feasibility and desirability of incorporating CAI programs into inservice teacher education.

Keith A. Hall
August 8, 1969

## TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

## LIST OF TABLES

COMPUTER-ASSISTED INSTRUCTION
AT GLADEVILLE, VIRGINIA

Summer, 1969

Objective

The goal of the project described in this report was to field test at a second location a program of inservice education in modern mathematics and mathematics teaching methods for elementary teachers in the Appalachian region.[1] An IBM 1500 instructional system with 16 student terminals was installed in the Gladeville Elementary School to administer the computer-based course to the teachers. This system was used from approximately 10:00 a.m. to 9:30 p.m., between May 19 and July 7, to provide individualized instruction for elementary school teachers and other educators who drove in from an average distance of approximately twenty-two miles. Records of the learning histories of the participating teachers were compiled and analyzed for evaluating the effectiveness of the course and for making course revisions.

Computer Configuration

An IBM 1500 student station consists of four optional display-response devices which may be used individually or in combination. The central instrument connected to the computer consists of a cathode-ray tube screen with sixteen horizontal rows and forty vertical columns for a total of 640 display positions. Information sufficient to fill the screen is available in microseconds from an internal random access disk. A light-pen device enables the learner to respond to displayed letters, figures and graphics by touching the appropriate place on the screen. A part of the CRT device is a typewriter-like keyboard which makes it possible for the learner to construct responses, have

---

[1] For a summary of the need for new techniques of inservice instruction in modern mathematics, compare pp. 1-3 in Hall, K. A., Principal Investigator, Inservice Mathematics Education for Elementary School Teachers Via Computer-Assisted Instruction, Interim Report R-19, Computer Assisted Instruction Laboratory, The Pennsylvania State University, University Park, Pennsylvania, June 1, 1969, mimeographed.

them displayed at any author-desired point on the CRT screen and receive rapid feedback in the form of an evaluative message. Four dictionaries of 128 characters each of the course author's own design are capable of being used simultaneously, thus, it would be technically feasible to teach the symbols of Sanskrit, Chinese, English, and Greek simultaneously by means of CAI. An image-projector loaded with a 16mm microfilm is capable of holding 1000 images on a single roll and of accessing forty images per second under program control. An audio play/record device has just recently become available but was not utilized for this project. An electric typewriter on the system is a separate device which enables the student to receive a hard copy of the interaction or dialogue between himself and the computer.

The central processing unit, which can accommodate up to a total of thirty-two student stations (each complete with four devices), is an IBM 1130 computer with 32,768 words of core storage. (Sixteen stations were sufficient to allow 150 to 200 students complete the instructional materials used for this project for about seven weeks.) In addition to the usual peripheral equipment, the central processor depends upon five IBM 2310 disk drives (2,560,000 words) for the storage of usable course information and operating instructions. Twin magnetic tape drives record the interaction between the program and the student for later analysis and course revision. Core storage cycle time is 3.6 microseconds and read/write time for disk storage is 27.8 microseconds per word.

## Instructional Program

The computer-assisted instruction course in mathematics for elementary teachers and methods of teaching mathematics for elementary teachers was developed by Professors C. Alan Riedesel, Marilyn N. Suydam, and Cecil R. Trueblood of The Pennsylvania State University. The course adheres rather closely to the CUPM Level 1 recommendation with about eighty per cent of the course devoted to mathematical content and twenty per cent devoted to the methods of teaching mathematics. The methods units were interspersed throughout the program so that each would be studied immediately following the presentation of the related content.

The course utilizes an integrated approach relying not only on tutorial activity at the computer terminal but on the integration of printed instructional materials and manipulative devices to be used at the terminal and in the teacher's classroom. Each participant in the project received a copy of Guiding Discovery in Elementary School Mathematics, by C Alan Riedesel, and published by Appleton-Century Crofts, a handbook containing suggested lesson plans and problem assignments, and an assortment of manipulative devices such as Cuisenaire rods and counting sticks for use in the teacher-student's own room. A detailed course description is included as Append , his report. A pre- and posttest of mathematics content, a pre- and posttest of the participant's attitude toward mathematics and a posttest of attitude toward CAI were administered to all participants in the project. The data from these inventories are documented in subsequent sections of this report.

## Participants

A total of 166 students registered for the computer-based inservice mathematics course at Gladeville. Sixteen of these early registrants never attended the first session, leaving a total of 150 active students. Five more Carroll County teachers who attended one session at the computer terminal dropped out after the first session, and seven others dropped out for a variety of personal reasons. The timing of the opportunity was awkward for most school personnel since the course began about three weeks before school was out and continued for a month into the normal vacation period. A total of 138 persons completed the CAI course of instruction, but failed to take the posttest. Of this number, relatively complete pre- and post-instruction data were obtained for 134, although there was a certain amount of missing information for every variable.

Table 1 shows the occupational composition of the group for whom data are available. Of the 29 persons who were classified as high school teachers, about fifty-nine per cent were seventh and eighth grade teachers whose experience is closely allied with that of primary and intermediate teachers.

The remainder of this report presents the accumulated data for 134 of the participants.

Table 1

Occupational Description of 134 Participants
for Whom Pre- and Posttest Data Were Available

| Occupation | Number | Per Cent |
|---|---|---|
| Primary School Teachers, Primary School Teacher Aides, and Intermediate Teachers | 65 | 48.5 |
| Junior and Senior High School Teachers | 30 | 22.4 |
| School Administrators and Coordinators | 16 | 12.0 |
| Others | 23 | 17.1 |
| Total | 134 | 100.0 |

# EVALUATION OF ACHIEVEMENT

Marilyn N. Suydam and Harold E. Mitzel

## Composition of the Mathematics Achievement Test

The "Test on Modern Mathematics," by Marilyn N. Suydam, Cecil R. Trueblood, and C. Alan Riedesel, was used as the pre- and posttest measure of achievement for the computer-assisted mathematics course (elmath), for the participants in this project. The 80-item test is designed to include a representative sampling of mathematical content from each of the 12 chapters in the course, and therefore provides a measure with which to test understanding of the concepts contained in the CAI mathematics program. Although about twenty per cent of the student's "on-line" time dealt with the teaching of mathematics in the elementary school, questions on this material were not included in the achievement examination. The most appropriate test for methods material acquisition is probably found in the classroom setting.

The 80 multiple-choice questions were selected from a pool of approximately three hundred items about which some preliminary performance data had been gathered. These items approximated the numbers of knowledge, understanding, and application objectives included in each chapter of the course. Texts in mathematics education which were used to construct the course were consulted in the preparation of the test questions. In addition, a mathematician evaluated each item for appropriateness to the course material and for mathematical accuracy.

Form G of the "Test on Modern Mathematics" was used as the pretest, while form H served as the posttest. The two forms contain the same items except that 1) the numerical values are changed in about one-half of the items, and 2) the order of answer options is different on almost all items in the two forms. While psychometric equivalence has not been established, we make the assumption that the two forms are equivalent since there were no substantive changes in content or format.

Results from Administrations of the Test

A total of 138 persons completed the CAI mathematics course (four failed to complete the posttest) at the Gladeville school. The pretest was administered prior to the students' first session on the course, while the posttest was administered at the session following each student's reaching the end of the course. In the intervening period of approximately seven weeks, the students spent an average of 19.25 hours on the program.

Table 2 shows the pre- and post-treatment results of the administration of the "off-line" mathematics achievement test. The increase in achievement is evident in the increase in the cumulative score column. Achievement in mathematics related to the instruction is also evidenced in the increase in the mean score from approximately fifty per cent on the pretest to approximately seventy per cent on the posttest.

If the assumption is made that the 80 items of the test represent an absolute criterion of achievement in the course, then theoretical mastery of the course objectives is attained when a student answers one hundred per cent of the items correctly. In most practical achievement test situations, a ninety per cent criterion is considered realistic. It is obvious that for this test, only 22 of the 134 students achieved the desired level; mastery at the ninety per cent level was not attained by the remaining 112 students.

The reasons for some deficiency in the measure can be attributed to 1) the fact that the items include some "transfer of knowledge" objectives which were not specifically taught in the CAI program, and 2) there are probably insufficient direct practice materials and short review quizzes within the program to enable the less able students to reach the desired level of mastery of the objectives. A careful re-examination of the test has been undertaken to eliminate items on objectives not specifically taught. Evaluation of student responses has also led to revision of the test for future use with the program. Changes in the instructional program which were indicated by the responses on the test have been annotated in subsequent sections of this report.

As shown in Table 2, approximately nineteen per cent of the Gladeville students had, as indicated by their performance on the pre-test, already

Table 2

Frequency Distributions of Pre- and Post-Mathematics Achievement for Educators Taught by CAI at Gladeville, Virginia, Summer 1969

| Per Cent of Criterion Test Correct | Frequency Pretest, Form G N = 134 | Cum. Freq. in Per Cent | Frequency Posttest, Form H N = 134 | Cum. Freq. in Per Cent |
|---|---|---|---|---|
| 95 - 99 | 1 | 100.00 | 8 | 100.00 |
| 90 - 94 | 5 | 99.3 | 14 | 94.0 |
| 85 - 89 | 7 | 95.5 | 9 | 83.6 |
| 80 - 84 | 4 | 90.3 | 12 | 76.9 |
| 75 - 79 | 3 | 87.3 | 16 | 67.9 |
| 70 - 74 | 5 | 85.1 | 14 | 56.0 |
| 65 - 69 | 8 | 81.3 | 9 | 45.5 |
| 60 - 64 | 5 | 75.4 | 11 | 38.8 |
| 55 - 59 | 9 | 71.6 | 9 | 30.6 |
| 50 - 54 | 14 | 64.9 | 10 | 23.9 |
| 45 - 49 | 14 | 54.5 | 12 | 16.4 |
| 40 - 44 | 20 | 44.0 | 5 | 7.5 |
| 35 - 39 | 11 | 29.1 | 2 | 3.7 |
| 30 - 34 | 16 | 20.9 | 3 | 2.2 |
| 25 - 29 | 8 | 9.0 | | |
| 20 - 24 | 3 | 3.0 | | |
| 15 - 19 | 1 | 0.7 | | |
| Mean | 51.40 | | 69.65 | |
| Median | 47.36 | | 71.64 | |
| Mode | 39.50 | | 74.50 | |

N. B. Descriptive statistics were calculated from grouped data.

achieved seventy per cent of the objectives of the course. For this group, there was relatively little room to show evidence of growth in the test situation. However, in an inservice teacher education program, it is not possible to withdraw the opportunity for self-improvement once the pretest results are available. Moreover, scores on a test are only one indication of the need for a specified body of material. While the test includes a representative sampling of the content, it is by the very nature of its length only a sampling Despite the fact that the test seems to indicate that nineteen per cent knew much of the material before taking the program, the development of the sequences and the wider range of concepts presented in the course possibly resulted in an increase in knowledge and understanding beyond what the particular test scores can indicate.

In spite of the limitations evident in the achievement test and/or in the program, the data show that the mean achievement for the students at Gladeville did increase. (The gain between pretest and posttest scores is significant at the .001 level.[2]) The program is effective in providing inservice education for teachers of elementary school mathematics and other educators.

[2] The raw score difference between pre- and posttest means was 14.36 which, when evaluated by t-test for correlated means, gave the following results:
$t = 17.14$ $p < .001$ d. f. = 133

# EVALUATION OF ATTITUDES TOWARD MATHEMATICS

Marilyn N. Suydam and Harold E. Mitzel

Two notions about attitudes toward mathematics are widely accepted: 1) that mathematics is disliked by most pupils, and 2) that the teaching of mathematics is disliked by most teachers. However, results of numerous surveys contradict these notions Many studies provide evidence which shows that pupils frequently select mathematics as their favorite or nearly favorite subject (Anderson, 1958, Chase, 1949, Curry, 1963; Dutton, 1956; Greenblatt, 1962, Herman 1963, Inskeep 1965; Mosher, 1952; Rowland, 1963, Stright, 1960).

As for teachers, Brown (1965) noted that while teachers feel inadequate in teaching mathematics they still like to teach it. Groff's (1963) results supported this contention. Huettig and Newell (1966) noted that positive statements increased with the amount of training which a teacher reported.

Evidence has also been presented that the pupils of teachers who liked arithmetic, liked it themselves (Chase, 1958; Greenblatt, 1962).

Thus, it seems important to determine what effect a computer-assisted instruction course in mathematics has on the attitude of educators toward mathematics.

## Development of the Mathematics Attitude Scale

The "Attitude Toward Mathematics" scale (by Marilyn N. Suydam and Cecil R. Trueblood) was developed from a pool of 75 items selected to express various feelings toward mathematics. The Likert format was used, with each statement worded in such a way that its content is favorable or unfavorable. Students then respond in terms of the degree to which they agree or disagree with the statement. Neutral items are not included. To reduce the potential effect of response set, care was taken to include an equal number of positively worded (favorable to mathematics) and negatively worded (unfavorable to mathematics) items.

The 75-item pool was submitted to 25 examinees who were asked to respond to each item with a five-point scale ranging from "strongly agree" to "strongly disagree." Scale scores were then derived for each item, and the final selection of 26 items was based on 1) the level of the scale scores, and 2) independence of content of the item.

The value of the variate on the attitude scale was obtained by assigning arbitrary numerical weights to the options. The theoretical extremes of a distribution of scores for the 26 items are 26 and 130, with a theoritical midpoint of 78.

On administrations of the "Attitude Toward Mathematics" scale to several hundred students, the reliability (i.e., a measure of internal consistency, Cronbach's Coefficient Alpha) has ranged from .92 to .98, with an average reliability of .96.

## Results from Administrations of the Scale at Gladville

The "Attitude Toward Mathematics" scale was administered both before students began the CAI course and after they had completed it. One hundred thirty-four students enrolled at the Gladeville center completed the scale following instruction.

Table 3 presents the results. The mean score on the pretest was 92.14, while the mean score for the same group of students after completion of the CAI mathematics course was 93.01, a mean increase of 0.87. When the difference was evaluated with a t test for correlated measures, this difference was found to be non-significant.[3]

Of far more importance is the fact indicated by the scores, the mean attitude score before teachers began the program was positive (greater than the scale's midpoint of 78) - not overwhelmingly so, but at least on the positive side of the balance. It is therefore hoped that the teachers will transmit a positive attitude about mathematics to their pupils, and thus the attitude of pupils toward mathematics will become increasingly positive.

[3]The difference between pre- and post-instruction means was evaluated by t-test for correlated measures with the following results:
$t = 0.926$   $p > .05$   d. f. = 133

Table 3

Distribution of Pre- and Posttest Attitude Scale Scores
for 134 Students in CAI Program
Gladeville, Virginia, Summer 1969

| Score | Pretest | Posttest |
|---|---|---|
| 120 - 129 | 5 | 6 |
| 110 - 119 | 18 | 18 |
| 100 - 109 | 26 | 26 |
| 90 - 99 | 35 | 33 |
| 80 - 89 | 19 | 21 |
| 70 - 79 | 14 | 16 |
| 60 - 69 | 13 | 11 |
| 50 - 59 | 2 | 2 |
| 40 - 49 | 1 | 0 |
| 30 - 39 | 1 | 1 |
| | 134 | 134 |
| Mean | 92.14 | 93.01 |
| Median | 93.00 | 94.00 |
| Standard Deviation | 17.81 | 17.48 |

N. B. Descriptive statistics were calculated from ungrouped data.

It should also be noted that fears that interaction with computer terminals might generate negative feelings toward the subject matter were unfounded. Hopefully, further computer use in teacher education can be used without fear of sabotaging subject matter motivation and interest.

# ANALYSIS OF RELATIONSHIPS AMONG ACHIEVEMENT MEASURES, ATTITUDE MEASURES, AND TIME MEASURES

Marilyn N. Suydam and Harold E. Mitzel

Further analysis of the data for the group of educators who were taught by the CAI mathematics program reveals some interesting interrelationships between pairs of the several variables. Interpretations of correlational data may provide the basis for future controlled study of specific aspects of interest.

Table 4 presents the means and standard deviations for seven variables involving achievement, attitude, and time devoted to the study of mathematics via CAI. The achievement pretest and posttest scores were attained on Forms G and H respectively of the 80-item "Test on Modern Mathematics," described in a previous section of this report. The attitude pre- and posttest scores were derived from the "Attitude Toward Mathematics" scale previously described. Both pretests were administered prior to the student's first session at the student station, while the posttests were taken immediately following the student's last session. In order to ascertain time spent by students while taking the CAI course, three measures were recorded: the number of separate sessions when each student was "on-line"; the number of days intervening between each student's first and final sessions (a rough indicator of the extent to which the course was massed or distributed); and the actual amount of time at the student terminal, as recorded by the computer.

Table 5 presents the correlations between the paired observations for these seven variables (two achievement measures, two attitude measures, and three time measures). It was expected that a high positive correlation would exist between achievement pre-and posttest scores. This is a generally prevalent finding since what a student achieves may be partially predicted by his entering level, or what he has achieved in the past. The correlation coefficient of .7823 is therefore an indication that high achievers on the pretest tended to be high achievers on the posttest, and low achievers tended to achieve at the lower levels on both tests. If, however, the achievement test had been a satisfactory mastery or criterion-referenced test, this correlation would be decidedly lower. The goal in aiding the student to achieve mastery of a body

Table 4

Means and Standard Deviations on Seven Variables for Educators Taught Modern Mathematics by CAI at Gladeville, Virginia, Summer 1969

| Variable | Mean | Standard Deviation | Number of Cases |
|---|---|---|---|
| Achievement pretest raw score | 40.73 | 15.27 | |
| Achievement posttest raw score | 55.23 | 13.94 | |
| Attitude pretest raw score | 92.11 | 17.93 | |
| Attitude posttest raw score | 92.92 | 17.58 | |
| Number of separate sessions | 8.18 | 4.06 | |
| Number of days between first and last session | 21.85 | 11.24 | |
| Number of hours "on-line" at terminal | 19.24 | 6.47 | |

f material is precisely to eliminate a strong pre-post relationship. All students, whether they scored high or low on the pretest, should reach approximately the same high level on the posttest. The present achievement test for the course is undergoing revision in order to more closely approximate the goal.

That the attitude pre- and posttest scores were highly correlated was also predictable. Measurable changes in attitude generally demand a longer time span than the seven weeks of this project. The correlation coefficient of .8448 is indicative that some relative changes in attitude did occur among the participants, as previously noted, the mean attitude score became slightly more positive during the instruction period, though the difference did not exceed chance variation.

The correlation coefficients between measures of achievement and attitude on the one hand, and time assessments on the other, are all negative. This observation is merely indicative of the fact that longer periods of time spent by students on the course and low achievement or attitude tended to be related.

Table 5

Zero-Order Correlations Between Measures on Seven Variables for Educators Taught Modern Mathematics by CAI at Gladeville, Virginia, Summer 1969

| Variable a | Variable b | Correlation Coefficient | Number of Cases |
|---|---|---|---|
| Achievement pretest score | Achievement posttest score | .7823 | |
| | Attitude pretest score | .6102 | |
| | Attitude posttest score | .6133 | |
| | Number of hours on terminal | -.5318 | |
| | Number of sessions | -.4387 | |
| | Number of days between first and last session | -.3284 | |
| Achievement posttest score | Attitude pretest score | .4747 | |
| | Attitude posttest score | .5739 | |
| | Number of hours on terminal | -.5925 | |
| | Number of sessions | -.3532 | |
| | Number of days between first and last session | -.2187[a] | |
| Attitude pretest score | Attitude posttest score | .8448 | |
| | Number of hours on terminal | -.1738[a] | |
| | Number of sessions | -.2976 | |
| | Number of days between first and last session | -.2557 | |
| Attitude posttest score | Number of sessions | -.3225 | |
| | Number of hours | -.2573 | |
| | Number of days between first and last session | -.2815 | |
| Number of hours on terminal | Number of sessions | .5313 | |
| | Number of days between first and last session | .3370 | |
| Number of sessions | Number of days between first and last session | .7579 | |

[a]This coefficient is not statistically significant at the five per cent level of confidence.

The negative coefficients, however, are generally not extreme and, in fact, two are not statistically significant. One exception is the relationship between pre- and posttest achievement and amount of time on the terminal (-.5318 and -.5925, respectively). High achievers typically spent less time at the student station than low achievers. Again we see a weakness in the combination of instructional programs/examinations, since theoretically learners with lower ability or lower previous knowledge should be able to use "time on the program" to compensate for their poor starting position.

Amount of time on terminal was found to be related to the number of sessions (.5313) and the number of lapsed days between first and last session (.3370). That these coefficients were no higher is related to the flexibility of scheduling possible with a CAI system. The coefficient of .7579 between numbers of sessions and lapsed days is similarly related to scheduling constraints.

The data relating to time "on-line" and achievement were also analyzed in another way to study the relationships existing between them. Correlations between posttest achievement and each measure of time were determined when achievement pretest scores were used as a co-variate, or held constant. Thus it was possible to look at the relationship which would have existed had all pretest achievement scores been equal.

The correlation coefficients between posttest achievement score and number of lapsed days (with pretest achievement constant) was -.0649, while the posttest achievement coefficient with number of sessions was -.0178 under the same conditions. Both of these coefficients are statistically nonsignificant. However, the coefficient between posttest achievement and number of hours on terminal (with pretest achievement constant) was -.3345. When pretest achievement was uncontrolled, the corresponding coefficient was -.5925, indicating that a portion, but not all, of the relationship between achievement and time on the terminal is explained by what the learner brings with him in the way of subject matter knowledge.

Frequency distributions for number of hours on terminal, number of lapsed days, and number of sessions are presented in Tables 6, 7, and 8, respectively.

Table 6

Frequency Distribution for Number of Hours on Terminal for 130 Educators Taught Modern Mathematics by CAI at Gladeville, Virginia, Summer 1969

| Number of Hours | Frequency |
|---|---|
| 39.1 - -- | 1 |
| 36.1 - 39.0 | 0 |
| 33.1 - 36.0 | 4 |
| 30.1 - 33.0 | 2 |
| 27.1 - 30.0 | 6 |
| 24.1 - 27.0 | 12 |
| 21.1 - 24.0 | 24 |
| 18.1 - 21.0 | 22 |
| 15.1 - 18.0 | 30 |
| 12.1 - 15.0 | 19 |
| 9.1 - 12.0 | 9 |
| -- - 9.0 | 1 |
| Total | 130 |

N. B. Mean = 19.60; Median = 18.95

Table 7

Frequency Distribution for Number of Days Intervening Between Initial and Final Sessions for 120 Educators Taught Modern Mathematics by CAI at Gladeville, Virginia, Summer 1969

| Number of Days | Frequency |
|---|---|
| 44 - 47 | 1 |
| 40 - 43 | 7 |
| 36 - 39 | 5 |
| 32 - 35 | 9 |
| 28 - 31 | 26 |
| 24 - 27 | 18 |
| 20 - 23 | 18 |
| 16 - 19 | 10 |
| 12 - 15 | 18 |
| 8 - 11 | 5 |
| 4 - 7 | 2 |
| 0 - 3 | 1 |
| Total | 120 |

N. B. Mean = 24.30 Median = 24.83

Table 8

Frequency Distribution for Number of Sessions on Terminal for 119 Educators Taught Modern Mathematics by CAI at Gladeville, Virginia, Summer 1969

| Number of Sessions | Frequency |
|---|---|
| 21 - -- | 1 |
| 19 - 20 | 0 |
| 17 - 18 | 3 |
| 15 - 16 | 3 |
| 13 - 14 | 4 |
| 11 - 12 | 19 |
| 9 - 10 | 38 |
| 7 - 8 | 31 |
| 5 - 6 | 13 |
| 3 - 4 | 4 |
| 0 - 2 | 3 |
| Total | 119 |

The data in Tables 6, 7, and 8 demonstrate the tremendous flexibility of an individually presented CAI course as might be compared with conventional instruction formats. Presented in a conventional manner in a classroom with a stand-up lecturer, we believe that this course in modern mathematics and the teaching of mathematics would require a minimum of 30 clock hours of in-class time. Under the CAI format with student-controlled progress, only seven students, or about five per cent of the enrollees, required more than 30 hours. At the same time, 29 students, or about twenty two per cent, required 15 or fewer hours to complete the program. (The median is 19.0 hours.) For this group of 29 students, we halved their instructional time.

In studying the temporal experiences of the group of educators who took the CAI mathematics course at Gladeville, note should be made of the extremes. On the number of hours at the student station measure (Table 6), the range was 30.1 hours or, viewed another way, it took the slowest student 4.3 times as long to complete the course as the fastest student. This finding, that CAI tends to accentuate individual differences in task completion time, has been characteristic of every one of our teaching experiences with this medium (c.f. Hall, 1969; Long and Riedesel, 1967).

In Table 8, the range of different sessions employed by the students was 19, indicating that many people, when provided the opportunity, preferred to work a small number of relatively long three to four-hour sessions. Others preferred and utilized a larger number of short sessions. These adaptations, made more or less spontaneously by students, tend to emphasize one of the potentially important advantages of computer-based instruction. A maximum amount of flexibility seems to be of particular significance for inservice or job concurrent training. We believe that the educational demand for inservice education is going to increase markedly in the years immediately ahead, and that CAI, based on our field experience in places like Gladeville, can help to satisfy that burgeoning need.

# CURRICULUM REVISIONS

Cecil R. Trueblood, Diane Knull, and Deborah Schrieber

Since the computer can automatically record and store all or selected student responses and response times, the instructors or course authors can later obtain a print-out of this student record data by means of special instructions. The purpose of this report is to indicate the type and number of curriculum revisions which were made based on the analysis of student records and on-site observations.

Using the data in the detailed student records and the original program, the authors determined whether a revision of course content or Coursewriter II instructions might improve student performance. The operation of the course at the Gladeville site yielded data which dictated the course revisions shown in Table 9.

Table 9

Type and Number of Course Revisions

| Operation Codes Requiring Revision | No. of Revisions |
|---|---|
| pr | 5 |
| ep | 6 |
| cb | 9 |
| dt | 3 |
| fn | 3 |
| wa feedback | 3 |
| un feedback | 9 |
| op code | 4 |
| ep responses | 3 |
| typographical | 3 |

After the discussion of each sample revision, two frames are shown. The first shows the frame before the revision and is labeled the "original version"; the second will be the frame after the correction under discussion was made and is labeled the "revised version."

CB

The cb allows for another correct response. Several cb's were added to the program to allow for correct answers which had not been anticipated. These touches in programing are thought to increase the student's feeling of responsiveness on the part of the computer system.

k111 - (original version)

```
prr
de  0/32
dt  0,0/4,0/40,0/6 x (1/2) = 6 x ?  What should replace the question mark?
ep  6/2,6/40,0//99/k111
de  10/22
fn  ed////
ca  2/cc
dt  16,0/2,16/40,0/Correct.
pa  20
un  uu
dt  16,0/2,16/40,0/6 x (1/2) = 6 x 2.  Type 2.
```

k111 - (revised version)

```
prr
de  0/32
dt  0,0/4,0/40,0/6 x (1/2) = 6 x ?  What should replace the question mark?
ep  6/2,6/40,0//99/k111
de  10/22
fn  ed////
ca  2/cc
cb  2/1/cc
dt  16,0/2,16/40,0/Correct.
pa  20
un  uu
dt  16,0/2,16/40,0/6 x (1/2) = 6 x 2.  Type 2.
```

EP

Enter and process (ep) locates the position on the screen where the student is to enter his responses. It also defines the space which he has available for his response. Several ep's had to be changed since only one line had been allowed for a student response and some students were using more than one line. The last lines were not being displayed on the screen. To correct this problem, ep's were changed to allow for a two-line response.

h64 - (original version)

```
pr
de  0/32
dt  0,0/6,0/40,0/Consider 648, 8253, and 587961. Each is divisible by 9.
    For each, what is true regarding the sum of the values
dt  ,0/2,/40,0/of the digits?
ep  10,0/////
fn  ed//b0,d//
aa  */aa
ld  ,ivide,9,nine,ivisible,prid,mult,excess,0,zero/b2
fn  mk///,
fn  es/nw/2/,///c
de  16/2
dt  16,0/2,16/40,0/Yes.
pa  20
un  uu
de  16/2
dt  16,0/2,16/40,0/Not completely correct. Try again.
```

h64 - (revised version)

```
pr
de  0/32
dt  0,0/6,0/40,0/Consider 648,8253, and 587961. Each is divisible by 9.
    For each, what is true regarding the sum of the values
dt  ,0/2 /40,0/of the digits?
ep  10,0/4,10/40,0//99/h64
fn  ed//b0,d//
aa  */aa
ld  ,ivide,9,nine,ivisible,prod,mult,excess,0,zero/b2
fn  mk///,
fn  es/nw/2/,///c
de  16/2
dt  16,0/2,16/40,0/Yes
pa  20
un  uu
de  16/2
dt  16,0/2,16/40,0/Not completely correct. Try again.
```

PRR

The problem restart (prr) operation is used to record the starting point for the student when he signs on to the course. Several prr's were changed to pr's because images needed by the student at that prr were not available to him, the image being used for previous frames.

g74 - (original version)

```
prr
de  0/32
dt  0,0/6,0/40,0/Is e x (e + 0) = (e x e) + (e x 0) a true statement?
ep  6,0/2,6/40,0//99/g74
de  16/16
fn  ed//b0,d//∧
aa  */aa
ld  es t T rue/b2
fn  mk///∧
fn  es/nw/1/ ///c
dt  16,0/2,16/40,0/Correct
pa  20
un  un
dt  16,0/2,16/40,0/It is true.  Type yes.
```

g74 - (revised version)

```
pr
de  0/32
dt  0,0/6,0/40,0/Is e x (e + 0) = (e x e) + (e x 0) a true statement?
ep  6,0/2,6/40,0//99/g74
de  16/16
fn  ed//b0,d//∧
aa  */aa
ld  es t T rue/b2
fn  mk///∧
fn  es/nw/1/ ///c
dt  16,0/2,16/40,0/Correct.
pa  20
un  un
dt  16,0/2,16/40,0/It is true.  Type yes.
```

DT

Display text (dt) presents a question or statement to the student. Some revisions were made so that the intent of the question would be clear to the student. Others were made to improve the readability of the questions.

5x20 - (original version)

```
prr
de  0/32
dt  0,0/6,0/40,0/Part B: What is the content and what strategies may be
    used in teaching addition?
pa  50
de  0/6
dt  0,0/6,0/40,0/Addition is usually the first basic operation studied in
    the elementary school. One reason for this is that
dt  ,0/6,0/40,0/addition is the most frequently used operation. The need
    for it starts when pupils want to find "how many" are in
*dt ,0/2,/40,0/set or combination of sets.
dt  ,0/2,/40,0/PRESS ENTER to go on.
epi 30,39/2,30/1,37//1/5x20
```

5x20 (revised version)

```
prr
de  0/32
dt  0,0/6,0/40,0/Part B: What is the content and what strategies may be
    used in teaching addition?
pa  50
de  0/6
dt  0,0/6,0/40,0/Addition is usually the first basic operation studied in
    the elementary school. One reason for this is that
dt  ,0/6,40,0/addition is the most frequently used operation. The need
    for it starts when pupils want to find "how many" are in
*dt ,0/2,/40,0/a set or combination of sets.
dt  ,0/2,/40,0/PRESS ENTER to go on
epi 30,39/2,30/1,37//1/5x20
```

FN

The function edit (fn) had to be changed so commas in student's response would be edited out. Some students were typing commas into their correct answers and the system was not allowing for these responses to be processed as correct. Simply changing the edit function to edit out commas solved this problem.

2x16 - (original version)

```
pr
de  0/32
dt  0,0/6,0/40,0/The pupils agreed that 7 x 7 and 7^2 describe the square
    labeled 49. What 2 names for 7^2 probably came from
dt  ,0/4,/40,0/observing the description and pattern just observed?
dt  12,5/2,12/40,0/a. seven to the second power
dt  16,5/2,16/40,0/b. seven squared
dt  20,5/2,20/40,0/c. square of seven
ep  22,0/2,22/40,0//99/2x16
fn  ed//b0,d//
de  24/8
ca  bc/cc
cb  cb/cc
dt  24,0/6,24/40,0/Very good. Seven squared or the square of seven seems
    to describe the square labeled 49.
pa  60
wa  ab/ww
sb  ba/ww
dt  24,0/6,24/40,0/7^2 is read as you've indicated, but haven't you learned
    another way to read 7^2? Try again.
wa  ca/ww
wb  ac/ww
dt  24,0/6,24/40,0/That's right. You've got one correct answer. Can you
    find the other that gives about the same description of the
dti ,0/2,/40,0/square labeled 49? Try again.
un  uu
dt  24,0/6,24/40,0/What two ways have you learned to read 7^2? Which
    provides the most graphic description of the square labeled 49?
dti ,0/2,/40,0/Try again.
```

FN - (Continued)

2x16 - (revised version)

```
pr
de  0/32
dt  0,0/6,0/40,0/The pupils agreed that 7 x 7 and 72 described the square
    labeled 49. What 2 names for 72 probably came from
dt  ,0/4,/40,0/observing the description and pattern just observed?
dt  12,5/2,12/40,0/a. seven to the second power
dt  16,5/2,16/40,0/b. seven squared
dt  20,5/2,20/40,0/c. square of seven
ep  22,0/2,22/40,0//99/2x16
fn  ed//b0,d//,/ /.
de  24/8
ca  bc/cc
cb  cb/cc
dt  24,0/6,24/40,0/Very good. Seven squared or the square of seven seems
    to describe the square labeled 49.
pa  60
wa  ab/ww
wb  ba/ww
dt  24,0/6,24/40,0/72 is read as you've indicated, but haven't you learned
    another way to read 72? Try again.
wa  ca/ww
wb  ac/ww
dt  24,0/6,24/40,0/That's right. You've got one correct answer. Can you
    find the other that gives about the same description of the
dti ,0/2,/40,0/square labeled 49? Try again.
un  uu
dt  24,0/6,24/40,0/What two ways have you learned to read 72? Which
    provides the most graphic description of the square labeled 49?
dti  ,0/2,/40,0/Try again.
```

WA FEEDBACK

This operation displays a response to the student's wrong answer; it gives him feedback regarding his response. The frame had previously been written without including feedback for a wrong answer. The revision of the frame shows the appropriate feedback for each wrong answer.

10x13 - (original version)

```
pr
de  0/32
dt  2,0/6,2/40,0/Question b in the textbook lesson is a brief example of
    one of the three strategies you looked at -- which one?
ep  8,0/2,8/40,0//99/10x13
de  12/20
fn  ed//b0,d//
aa  */aa
ld  /step/b2
fn  mk///.
fn  es/nw/1/.///c
dt  16,0/6,16/40,0/Good!  The two questions in b lead the child, one step
    at a time.  Since this is the first instance on the page where
dt  ,0/4,/40,0/the child is asked about negative numbers, this is
    particularly useful.
pa  100
un  uu
dt  16,0/4,16/40,0/Type non-verbal, collective thinking, or step-by-step.
```

<u>WA FEEDBACK</u> - (Continued)

10x13 - (revised version)

```
pr
de  0/32
dt  2,0/6,2/40,0/Question b in the textbook lesson is a brief example of
    one of the three strategies you looked at -- which one?
ep  8,0/2,8/40,0//99/10x13
de  12/20
fn  ed//b0,d//
aa  */aa
ld  .step/b2
fn  mk///.
fn  es/nw/1/.///c
dt  16,0/6,16/40,0/Good!  The two questions in b lead the child, one step
    at a time.  Since this is the first instance on the page where
dt  ,0/4,/40,0/the child is asked about negative numbers, this is
    particularly useful.
pa  100
aa  */aa
ld  non verbal/b2
fn  mk///
fn  es/nw/2/ ///w
dt  20/6//In the non-verbal strategy, the teacher presents the lesson
    without talking.  Isn't she talking in this lesson?
dt  ///Try again.
un  uu
dt  16,0/4,16/40,0/Type non-verbal, collective thinking, or step-by-step.
```

UN FEEDBACK

The addition of feedback for an unrecognized response--one not anticipated as either right or wrong--allows the student to determine the correct response.

f08 - (original version)

```
pr
de  0/32
dt  0,0/6,0/40,0/Subtraction can also be explained by using sets.  First,
    how can we explain addition by using sets?
ep  8,0/2,8/40,0//99/f08
de  10/22
aa  */aa
ld  .union.U.joining.combining.pooling.disjoint/b2
fn  mk///.
fn  es/nw/2/.///c
dt  18,0/2,18/40,0/Right.
pa  20
br  f09
wa  union/ww
dt  18 0/4,18/40,0/Addition can be explained by using disjoint sets.
pa  40
br  f8x1
un  uu
dt  18,0/6,18/40,0/Hint:  The union or joining of what kind of sets?  Type
    "union of ____________ sets."
un
dt  18/6//Type:  union of disjoint sets.
```

f08 - (revised version)

```
pr
de  0/32
dt  0,0/6,0/40,0/Subtraction can also be explained by using sets.  First,
    how can we explain addition by using sets?
ep  8,0/2,8/40,0//99/f08
de  10/22
aa  */aa
ld  .union.U.joining.combining.pooling.disjoint/b2
fn  mk///.
fn  es/nw/2/.///c
dt  18,0/2,18/40,0/Right.
pa  20
br  f09
wa  union/ww
dt  18,0/4,18/40,0/Addition can be explained by using disjoint sets.
pa  40
br  f8x1
un  uu
dt  18,0/6,18/40,0/Hint"  The union or joining of what kind of sets?  Type
    "union of __________sets."
```

<u>OP CODE</u>

Op code revisions consist of changing a pause (pa) to "space to continue" followed by a pae. This revision was necessary when feedback for a correct response did not appear on the screen long enough for the student to read it. The cnange to "space to continue" and the pae allowed the student to read the feedback at his own rate.

The following illustration shows a de Op code revision. This type of Op code revision was made because the screen (CRT) was not completely erasing itself when the correct answer feedback was shown. A de was inserted that would erase the CRT at the desired time and place.

a47 - (original version)

```
pr
de  0/32
dt  0,0/6,0/40,0/How many subsets could be formed from the set
    consisting of (Atlantic, Saturday Review, Newsweek)?
ep  7,0/2,7/40,0//99/a47
fn  ed//b0,d//
ca  8/cc
cb  eight/cc
dt  16,0/2,16/40,0/Eight is correct.
pa  20
un  uu
dt  10,0/6,10/40,0/The subsets are:
    1)  ()
    2)  (Atlantic)
dt  ,0/6,/40,0/3)  (Saturday Review)
    4)  (Newsweek)
    5)  (Atlantic, Saturday Review)
dt  ,0/6,/40,0/6)  (Atlantic, Newsweek)
    7)  (Saturday Review, Newsweek)
    8)  (Atlantic, Saturday Review
dt  ,0/2,0/40,0/    Newsweek).  Type eight.
```

OP CODE - (Continued)

a47 - (revised version)

```
pr
de  0/32
dt  0,0/6,0/40,0/How many subsets could be formed from the set
    consisting of (Atlantic,
    Saturday Review, Newsweek)?
ep  7,0/2,7/40,0//99/a47
fn  ed//b0,d//
de  10/22
ca  8/cc
cb  eight/cc
dt  16,0/2,16/40,0/Eight is correct.
pa  20
un  uu
dt  10,0/6,10/40,0/The subsets are:
    1)  ()
    2)  (Atlantic)
dt  ,0/6,/40,0/3)  (Saturday Review)
    4)  (Newsweek)
    5)  (Atlantic, Saturday Review)
dt  ,0/6,/40,0/6)  (Atlantic, Newsweek)
    7)  (Saturday Review, Newsweek)
    8)  (Atlantic, Saturday Review
dt  ,0/2,/40,0/     Newsweek). Type eight.
```

The foregoing revisions are based on problems occurring in "on-line" presentation of the program. Although one-line summaries of the students' performances were received, there was not sufficient time to completely study and digest student records. Future revision will include the analysis and use of complete student records.

## Student Handbook Revisions

Revisions of the handbook consisted mainly of correction of typographical errors and clarification of verbal and pictorial ideas presented.

Typographical revisions include relatic of numbers in the figures to help clarify the meaning of the figures. Also misspellings and punctuation errors were corrected, as was spacing.

Grammatical syntax was refined in order to clarify statements in the Handbook. In several instances additional statements were made to establish more firmly the relationship between the concept presented by the activity and the corresponding illustration.

Several illustrations were redone to correct errors and to make the concept presented more explicit. An inadverently omitted illustration was added. The Handbook was reprinted and organized into two separate volumes, and the Table of Contents was extended to include a more detailed outline of the material in each part of the Handbook.

# EXPRESSED STUDENT OPINION TOWARD COMPUTER-ASSISTED INSTRUCTION

Karl G. Borman

In evaluating a teacher or, more generally, a mode of instruction, some attention must be paid to the students' opinions of the mode of instruction. For example, a teacher is perceived by his students as being dull, boring, domineering, self-centered, etc., the probability is high that the students will neither be motivated to attend class regularly, nor to apply what was learned in the classroom to their everyday lives. Conversely, if a teacher is perceived by his students as being stimulating, interesting, and student-centered, the probability is increased that the student will attend class regularly, learn as much as possible about the subject material, and apply what he learned in the classroom to everyday problems. Numerous experimental investigations in education and psychology support the above conclusion (Gage, 1963).

The Student Opinion Survey described in this section of the Gladeville report is an instrument designed to measure a student's opinion toward Computer Assisted Instruction (CAI) as an educational technique.

## The Opinion Survey

The instrument, composed of 42 items related to the student's experiences while taking a course via CAI, is administered at the computer terminal (on-line administration). The items are adapted from a paper and pencil test (off-line administration) previously developed at Penn State (Brown, 1966) and revised on the basis of subsequent data (Borman, 1969). Each item is a statement relative to computer-assisted instruction

The students taking the Opinion Survey use the light pen to indicate the degree to which they agreed with the statement (strongly agree, agree, uncertain, disagree, strongly disagree) or the degree of applicability of the statement (all of the time, most of the time, some of the time, very seldom, never) (see Appendix B). A weight of 1 to 5 was assigned to each response to indicate the degree to which the response described a favorable opinion toward CAI.

This method of weighting provides for a spread of scores between 42, indicating an unfavorable opinion toward CAI, and 210, indicating a favorable attitude toward CAI. A theoretical neutral score would be 126.

Following each response to each item, the student was given the opportunity to type comments (up to 200 characters) he wished to make related to that item in order to clarify or further explain the reasons for his answer.

In addition, following the 42 structured items, the student was asked to type a response of not more than 200 characters explaining why he did or did not like CAI. These responses, as well as the optional comments, were not scored and did not enter into a student's total opinion score.

## Administration

Upon the completion of the modern mathematics course (Elmath), students were instructed to sign on to SOS (Student Opinion Survey). Data were available on 91 of the 138 students who completed Elmath. However 28 of the students completed SOS before the course was revised, and these students were excluded from the analyses. The resulting total of 63 students provided the data for this report.

In all cases the students were told to be frank, that there was no one right answer to a question, that their opinion would be kept confidential and that they were required to answer each question.

## Results

The coefficient alpha reliability of the Student Opinion Survey administered at this location, was .88 which compares favorably with previous data.[4]

It appears that a majority of the 63 students comprising the sample of students taking the computer assisted instruction course on Elmath at Gladeville, Virginia, had a favorable opinion toward computer assisted instruction upon their completion of the course. It does not appear that their opinion was

---

[4] *op. cit.*, Hall, Keith A.

related to their achievement posttest scores, and it is still questionable whether or not their opinion score is related to the time required to complete the course.

## Comments

These results are also verified by the comments that the students typed upon conclusion of the formal student opinion survey. Some typical comments follow.

> "I liked the course because I could progress at my own speed. Nobody was pushing me."
>
> CAI is "a new and refreshing approach to almost any course material."
>
> "Mathematics is not one of my favorite subjects. The computer made it seem a bit different."
>
> "A fine course."
>
> "I liked CAI because I could take the courses at my convenience."
>
> ". . .You look forward to attending classes."
>
> "The course was fun."
>
> "Fascinated by a new tool. Would like to use it on community college level with younger students."
>
> "Have always actively disliked math; thoroughly enjoyed this course."
>
> "It gave some insight into the method of presentation of materials."
>
> "It was a lot of fun--stimulating."
>
> "Would like to use it in business classes of mine on college level."

There were also a few negative comments, the most common that the students could not get the computer to accept alternative correct answers.

## Conclusion

In conclusion, it appears that computer assisted instruction resulted in a very favorable attitude toward CAI. It may be inferred that the students were highly motivated to learn and would be willing to take further instruction via CAI.

# COMPUTER SYSTEM OPERATION AND UTILIZATION

Stanley Mechlin and Fred Chase

The IBM 1500 system was installed at the Gladeville Elementary School on May 12, 1969, and became operational on May 19. The one-week "set-up" time, which we believe to be typical, points to the cost advantage of van-mounting the computer with a consequent reduction of operational time loss from seven days to about one or two days. The last day of system operation at Gladeville was July 7, yielding a total of 39 actual operating days at the location. Table 10 reflects the daily schedule of operation which was varied to accommodate the needs of the students.

Table 10

Daily Time Schedule of Operation
at Gladeville Elementary School

| Daily Time Schedule | Number of Operating Days |
|---|---|
| 10:00 a.m. to 9:30 p.m. | 12 |
| 11:00 a.m. to 9:30 p.m. | 15 |
| 1:00 p.m. to 9:30 p.m. | 8 |
| 10:00 a.m. to 5:30 p.m. (Saturdays) | 4 |
| Total Days Operational | 39 |

The fourth week of operation was chosen as an illustration of terminal utilization. By the fourth week of operation, procedures were clear to most students and a steady rhythm had been approximated. Before this time, students were arranging car pools and exploring the flexibilities in scheduling their sessions. Also, during the first weeks, the students were given estimates of the total number of hours required to complete the course which was extrapolated from the time already spent and the fraction of the course already completed. By the fifth, sixth, and seventh weeks, increasing numbers of students had completed the course (Table 11).

Table 11

Elapsed Time to Complete CAI Elmath Course
For 53 Randomly Chosen Elementary School Teachers

| Number of Teachers Finished | Cumulative Number of Operating Days | Date |
|---|---|---|
| 12 | 26 | June 17 |
| 37 | 32 | June 25 |
| 53 | 39 | July 7 |

For the fourth week (of 5 days), the fraction of available terminal hours actually used, based on 15 available terminals, was 974 hrs./1545 hrs. or 63 per cent. It is noteworthy that at certain times for each day the terminal utilization is considerably higher. During the prime hours (commonly late afternoon and evening) the utilization is 80-90 per cent.

It is clear that the system was not used to its maximum capacity in Gladeville and that probably another 50 students could have been accommodated. One alternative way to increase system usage would be to increase the instructional material by adding other courses relevant for the same sized service groups.

System Performance

Approximately three thousand terminal hours were logged by the system in the 39 days of operation. These hours were exclusive of demonstrations and "on-line" tests. Only 30 terminal hours, or about one per cent, were lost from all causes, including electrical power failures, operating errors, and software and hardware malfunctions. Three or four students were delayed by the latter for about fifteen minutes each on one accasion. The remainder of the lost terminal time was composed of one- to five-minute delays per student. In no instance was a scheduled student turned away or sent home because of terminal or system malfunction. Likewise, during the seven weeks, it was unnecessary to telephone and cancel the appearance of a scheduled student.

The computer and terminals were serviced from the IBM office at Roanoke, Virginia, a distance of 75 miles, and the customer engineer resided at Radford, about 50 miles away. In spite of these seemingly poor service arrangements, the system performance, in our opinion, was equal to that of most permanent computer installations located in densely populated metropolitan areas.

References


Anderson, George R. These eighth graders don't hate arithmetic. Mathematics Teacher, Volume 51, April 1958, pp. 267-269.

Brown, Bobby R. An instrument for the measurement of expressed attitude toward computer assisted instruction. In Semi-Annual Progress Report, No. R-5, Experimentation with Computer-Assisted Instruction in Technical Education, Project No. 5-85-074, prepared by Harold E. Mitzel, et al., University Park: The Pennsylvania State University, December 31, 1966, pp. 95-104.

Brown, Gerald W. An in-Service program in arithmetic. Elementary School Journal. Volume 66, November 1965, pp. 75-80.

Borman, Karl G. Expressed student opinions toward computer-assisted instruction. Inservice Mathematics Education for Elementary School Teachers Via Computer Assisted Instruction, prepared by Keith A. Hall, et al., University Park; The Pennsylvania State University, June 1, 1969, pp. 31-40, No. R-19.

Chase, W. Linwood and Wilson, Gilbert M. Preference studies in elementary school social studies. Journal of Educational Research, Volume 140; April 1958, pp. 2-8.

Dutton, Wilbur H. Attitudes of junior high school pupils toward arithmetic. School Research, Volume 64, January 1956, pp. 18-22.

Gage, N. L. (ed.) Handbook of Research on Teaching. Chicago: Rand McNally and Co., 1963.

Greenblatt, E. L. An analysis of school subject preferences of elementary school children of the middle grades. Journal of Educational Research, Volume 55, August 1962, pp. 554-560.

Groff, Patrick J. Self-estimates of ability to teach arithmetic. The Arithmetic Teacher, Volume 10, December 1963, pp. 479-480.

Herman, Wayne L., Jr. How intermediate children rank the subjects. Journal of Educational Research, Volume 56, April 1963, pp. 435-436.

Huettig, A. and Newell, John M. Attitudes toward introduction of modern mathematics program by teachers with large and small number of years' experience. The Arithmetic Teacher. Volume 13, February 1966, pp. 125-130.

Inskeep, J. and Rowland, M. An analysis of school subject preferences of elementary school children of the middle grades: another look. Journal of Educational Research, Volume 58, January 1965, pp. 225-228.

Mosher, Howard H. Subject preferences of girls and boys. School Research, Volume 60, January 1952, pp. 34-38.

Rowland, M. and Inskeep, J. Subject preferences of upper elementary school children in Cajon Valley Union School District. California Journal of Educational Research, Volume 14, September 1963, pp. 187-191.

Stright, Virginia M. A study of the attitudes toward arithmetic of students and teachers in the third, fourth, and sixth grades. The Arithmetic Teacher, Volume 7, October 1960, pp. 280-286.

# Appendix A

## Course Description: <u>elmath</u>

The Pennsylvania State University

Computer Assisted Instruction Laboratory
201 Chambers Building
University Park, Pennsylvania 16802

Course Description: elmath

The CAI course elmath is designed to present mathematical content and methods of teaching that content in the elementary school. The content component was developed at The Pennsylvania State University by Dr. C. Alan Riedesel and Dr. Marilyn N. Suydam. The methods component was developed by Dr. Cecil R. Trueblood with Dr. Riedesel and Dr. Suydam.

The primary purpose of the content materials is to present the mathematics which a teacher should know in order to develop a successful program in the elementary school. It is based on CUPM recommendations for Level 1 courses, modified to meet the actual requirements of the schools in which it is visualized for use. The methods materials place stress on various strategies and techniques, including the use of manipulative materials.

As over-all learning outcomes, the teacher should be able to understand and apply:

(1) the mathematical content

(2) generalizations about teaching procedures, including:

  (a) Physical world situations should be used to facilitate concept development.

  (b) Many varying materials should be used to facilitate concept development.

  (c) Experiences should range from the concrete to the abstract,

  (d) Individual differences must be considered in planning and in teaching.

  (e) Pupils should be asked to discover and use many varying ways of finding solutions to problems.

  (f) Pupils should be asked to explain, deduce, generalize, and apply.

  (g) Questions of many types should be asked to provoke discussion, develop concepts, and refocus on problems.

In addition to the CAI program, a textbook on teaching elementary school mathematics is required: Riedesel, C. Alan, Guiding Discovery in Elementary

*School Mathematics* (New York: Appleton-Century-Crofts, 1967). A handbook with a summary of mathematical content and a section on activities and materials to use in the classroom is also provided: Part I, *Help to You in Learning Mathematics*, by Roy F. Shortt (Keuka College, Keuka Park, New York), and Part II, *Help to You in Teaching Mathematics*, by Cecil R. Trueblood (The Pennsylvania State University).

For use in evaluation of learning, there are an eighty-item test ("A Test on Modern Mathematics," Forms G and H, by Marilyn N. Suydam, Cecil R. Trueblood, and C. Alan Riedesel) and an attitude scale ("Attitude Toward Mathematics," by Marilyn N. Suydam and Cecil R. Trueblood). A scale to measure changes in attitude toward CAI is also available.

An outline of the course follows.

## Chapter 1: Sets and Early Number Experiences

### Content

1. Sets
    a. Elements of sets
    b. Finite and infinite sets
    c. Defined sets
    d. Set notation
    e. Empty set
    f. Universal set
    g. Subsets

2. Set relationships
    a. Equality
    b. Equivalence

3. Set operations
    a. Union
    b. Intersection

4. Complement of a set

### Methods

This section focuses attention on why and how sets are presented in early number work. Attention is also directed toward the materials and techniques the teacher should use and the questions she should ask. Levels of pupil performance are considered in terms of types of pupil response.

## Chapter 2: Exponents

Content

1. Interpreting exponential notation
   a. Repeated factors
   b. Powers: base and exponent

2. Expressing in exponential form

3. Expanding from exponential form

4. Computation with exponents
   a. Multiplication
   b. Division
   c. Addition and subtraction

5. Zero as an exponent

6. Using expanded notation

Methods

How to teach exponential notation so that pupils see its usefulness is featured. Various pupil-teacher exchanges are presented. Use is made of graph paper and blocks to illustrate exponential forms.

## Chapter 3: The Hindu-Arabic System

### Content

1. Numerals and word names for numbers

2. Place value
   a. Numerals and names through thousands place
   b. Patterns
      (1) Powers of 10
      (2) Expanded form and standard numerals

   c. Chart: periods and place value through quadrillions
      (1) Reading the numeral
      (2) Completing the chart

### Methods

Introducing pupils to the use of place value charts is considered. This is connected with work with the abacus and multi-base arithmetic blocks. The reading of numerals to quadrillions is also considered.

## Chapter 4: Other Numeration Systems

### Content

1. Introduction to base eight
   a. Symbols: counting
   b. Place value
   c. Changing from base ten to base eight
      (1) Finding powers of the base
      (2) Division by the base

2. Introduction to base five
   a. Changing from base five to base ten
   b. Changing from base ten to base five

3. Characteristics of any numeration system
   a. Number of symbols
   b. Writing the base

4. Introduction to base twelve
   a. Changing from base twelve to base ten
   b. Changing from base ten to base twelve

5. Introduction to base two
   a. Changing from base ten to base two
   b. Changing from base two to base ten

6. Addition in other bases
   a. Base five
   b. Base two

7. Multiplication in base five

### Methods

Ways of introducing other numeration systems are presented. Use of materials such as the place value chart is considered, and attention is directed to points at which pupils may have difficulty.

## Chapter 5: Addition of Whole Numbers

### Content

1. Addition as a binary operation

2. Addition as one of four operations
   a. Relation to subtraction
   b. Relation to multiplication

3. Addition as the union of disjoint sets

4. Counting as the basis for addition: use in problem solving

5. Aids for teaching addition
   a. Abacus
   b. Number line
   c. Cuisenaire rods
   d. Place value frame

6. Properties and principles of addition
   a. Closure
   b. Commutativity
   c. Associativity
   d. Identity element

7. Addition basic facts: use of the table

8. Addition algorithms for multi-digit examples
   a. Use of place value
   b. Use of properties
   c. Regrouping
   d. Expanded notation forms

9. Historical forms for addition
   a. Sandboard method
   b. Scratch method
   c. Front-end addition

10. Checking addition
   a. Excess of nines
   b. Excess of elevens

### Methods

For this chapter, the methods component is interwoven with the content. Stress is placed on the use of verbal problems and manipulative materials such as the abacus and Cuisenaire rods.

## Chapter 6: Subtraction of Whole Numbers

### Content

1. Subtraction on the number line

2. Subtraction as the inverse of addition

3. Terminology
   a. Addend, missing addend, sum
   b. Minuend, subtrahend, difference

4. Subtraction in terms of sets
   a. Complements
   b. Difference between universal set and subset

5. Properties and principles of subtraction
   a. Closure
   b. Commutativity
   c. Associativity
   d. Compensation and renaming

6. Subtraction basic facts: use of the addition table

7. Subtraction algorithms
   a. For basic facts
      (1) Additive method
      (2) Take-away method
   b. For multi-digit examples
      (1) Decomposition
         (a) Additive
         (b) Take-away
      (2) Equal additions
         (a) Additive
         (b) Take-away

8. Checking subtraction
   a. Adding
   b. Excess of nines
   c. Excess of elevens
   d. Complementary method
   e. Scratch method

9. Subtraction in base eight

## Methods

Procedures for introducing subtraction to pupils are developed. Also reintroduction using the abacus as a vehicle is presented, and attention is focused on ways of teaching multi-digit subtraction using expanded notation.

## Chapter 7: Multiplication of Whole Numbers

### Content

1. Multiplication as repeated addition, using the number line

2. Terminology
   a. Multiplier, multiplicand, product
   b. Factors and product

3. Multiplication in terms of sets

4. Arrays and ordered pairs

5. Properties and principles of multiplication
   a. Identity element
   b. Closure
   c. Commutativity
   d. Associativity
   e. Distributivity

6. Multiplication basic facts: use of the table

7. Multiplication algorithms for multi-digit examples
   a. Regrouping
   b. Use of place value

8. Checking multiplication
   a. Use of properties
   b. Excess of nines
   c. Excess of elevens

9. Historical forms for multiplication
   a. Finger reckoning
   b. Lightning method
   c. Scratch method
   d. Lattice method
   e. Duplation methods

10. Modulus multiplication
    a. Mod 2
    b. Mod 7

### Methods

Use of arrays in teaching multiplication is developed. Emphasis is placed on providing pupils with varying methods for finding answers to multiplication questions.

## Chapter 8: Division of Whole Numbers

### Content

1. Relation of division
   a. To multiplication
   b. To subtraction

2. Terminology
   a. Dividend, divisor, quotient
   b. Types: partition and measurement

3. Properties and principles of division
   a. Closure
      (1) Exact division
      (2) Inexact division
   b. Commutativity
   c. Associativity
   d. Right distributivity
   e. Use of zero except as a divisor
   f. Identity element

4. Division algorithms
   a. For basic facts: use of the multiplication table
   b. For multi-digit examples
      (1) Subtracting groups of the divisor
      (2) Use of place value
      (3) Estimation of quotient
         (a) Approximation
         (b) Compensation
         (c) Determining devisibility

5. Historical forms for division
   a. Galley method
   b. A danda method
   c. Division by factors
   d. Excess of nines

6. Division in base four

### Methods

Procedures fo) the diagnosis of pupil difficulties in division are developed. Provision for individual differences is focused on through the study of procedures for estimating the quotient in division.

## Chapter 9: Functions

(to be developed)

## Chapter 10: Integers

### Content

1. Defining the set of integers
   a. Negative signed numbers
   b. Additive inverse

2. Computation with integers

3. Properties and principles of integers
   a. Closure
   b. Commutativity
   c. Associativity
   d. Distributivity
   e. Identity element

4. Order relations of integers

### Methods

Three strategied for introducing a lesson are analyzed and compared. The way in which a teacher can use a textbook with other materials is developed.

# Chapter 11: Fractions

## Content

1. Defining the set of rational numbers

2. Terminology of fractions

3. Uses of fractions
   a. To express parts of a group and parts of a whole
   b. To name a rational number
   c. To indicate division
   d. To express a ratio

4. Characteristics of fractions
   a. Identity element
   b. Equivalence
   c. Cross-products test
   d. Renaming in simplest form
      (1) Prime numbers
      (2) Composite numbers
      (3) Numbers that are relatively prime

5. Order relations of fractions; mixed forms

6. Properties of fractions
   a. Commutativity
   b. Associativity
   c. Distributivity

7. Computation with fractions
   a. Addition
      (1) Like denominators
      (2) Unlike denominators
   b. Finding the L.C.M.
   c. Finding the G.C.D.
   d. Subtraction
      (1) Like denominators
      (2) Unlike denominators
   e. Multiplication
   f. Division
      (1) Common denominator method
      (2) Multiplicative inverse method (inverse)

## Methods

Attention if focused on a lesson plan for summarizing the various uses of fractions. The selection of behavioral objectives and analysis of strengths and weaknesses of the plan are included.

## Chapter 12: Decimals

### Content

1. Place value for decimals

2. Reading and writing decimals

3. Locating decimals on the number line

4. Renaming
   a. Fractions as decimals
   b. Decimals as fractions

5. Terminating decimals

6. Non-terminating decimals
   a. Repeating
   b. Non-repeating

7. Computation with decimals

### Methods

Use of a physical world situation to introduce decimals is emphasized with the presentation of a lesson with an odometer. Pupil p. -icipation through the use of multiple solutions is reviewed, and non-verbal problems are suggested.

# Chapter 13: Ratio and Per Cent

## Content

1. Ratio
   a. Expressing ratios
   b. Solving problems with ratios
   c. Using the cross-product method

2. Per cent
   a. Three types of problems
      (1) What is N% of a number?
      (2) What per cent is one number of another number?
      (3) Find the total (100%) when a per cent is known
   b. Five approaches to solving each type of problem
      (1) Decimal
      (2) Ratio
      (3) Unitary-analysis
      (4) Formula
      (5) Equation

## Methods

This section is essentially a review and test of material presented in chapter 10 of the course textbook by Riedesel. When and how ratio and per cent should be developed are emphasized.

# Appendix B

## Student Opinion Toward Computer-Assisted Instruction

STUDENT OPINION TOWARD COMPUTER-ASSISTED INSTRUCTION

1. The method by which I was told whether I had given a right or wrong answer became monotonous.

| | | | | |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |

2. Nobody really cared whether I learned the course material or not.

| | | | | |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |

3. I felt challenged to do my best work.

| | | | | |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |

4. I felt isolated and alone.

| | | | | |
|---|---|---|---|---|
| All the time | Most of the time | Some of the time | Very Seldom | Never |

5. I felt as if someone were engaged in conversation with me.

| | | | | |
|---|---|---|---|---|
| All the time | Most of the time | Some of the time | Very Seldom | Never |

6. As a result of having studied by this method, I am interested in learning more about the subject matter.

| | | | | |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |

7. I was more involved in operating the terminal than in understanding the course material.

| | | | | |
|---|---|---|---|---|
| All the time | Most of the time | Some of the time | Very Seldom | Never |

8. The learning was too mechanical.

| | | | | |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |

9. I felt as if I had a private tutor.

| | | | | |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |

10. The equipment made it difficult to concentrate on the course material.

| | | | | |
|---|---|---|---|---|
| All the time | Most of the time | Some of the time | Very Seldom | Never |

11. The situation made me quite tense.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

12. Computer-assisted instruction, as used in this course, is an inefficient use of the student's time.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

13. My feeling toward the course material after I had completed the course was favorable.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

14. I felt frustrated by the situation.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

15. I found the computer-assisted instruction approach in this course to be inflexible.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

16. Material which is otherwise interesting can be boring when presented by CAI.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

17. I was satisfied with what I learned while taking the course.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

18. In view of the amount I learned, this method seems superior to classroom instruction for many courses.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

19. I would prefer computer-assisted instruction to traditional instruction.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

20. Computer-assisted instruction is just another step toward de-personalized instruction.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

21. I was concerned that I might not be understanding the material.

| | | | | |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |

22. The responses to my answers seemed appropriate.

| | | | | |
|---|---|---|---|---|
| All the time | Most of the time | Some of the time | Very Seldom | Never |

23. I felt uncertain as to my performance in the programmed course relative to the performance of others.

| | | | | |
|---|---|---|---|---|
| All the time | Most of the time | Some of the time | Very Seldom | Never |

24. I was not concerned when I missed a question because nobody was watching me.

| | | | | |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |

25. I found myself just trying to get through the material rather than trying to learn.

| | | | | |
|---|---|---|---|---|
| All the time | Most of the time | Some of the time | Very Seldom | Never |

26. I knew whether my answer was right or wrong before I was told.

| | | | | |
|---|---|---|---|---|
| All the time | Most of the time | Some of the time | Very Seldom | Never |

27. In a situation where I am trying to learn something, it is important to me to know where I stand relative to others.

| | | | | |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |

28. I guessed at the answers to some questions.

| | | | | |
|---|---|---|---|---|
| All the time | Most of the time | Some of the time | Very Seldom | Never |

29. I was aware of efforts to suit the material specifically to me.

| | | | | |
|---|---|---|---|---|
| All the time | Most of the time | Some of the time | Very Seldom | Never |

30. I was encouraged by the responses given to my answers of questions.

| | | | | |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |

31. In view of the time allowed for learning, I felt too much material was presented.

| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |
|---|---|---|---|---|

32. I entered wrong answers in order to get more information from the machine.

| All the time | Most of the time | Some of the time | Very Seldom | Never |
|---|---|---|---|---|

33. I felt I could work at my own pace.

| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |
|---|---|---|---|---|

34. Questions were asked which I felt were not related to the material presented.

| All the time | Most of the time | Some of the time | Very Seldom | Never |
|---|---|---|---|---|

35. I was aware of the flickering screen while I was taking the course.

| All the time | Most of the time | Some of the time | Very Seldom | Never |
|---|---|---|---|---|

36. Material which is otherwise boring can be interesting when presented by CAI.

| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |
|---|---|---|---|---|

37. I could have learned more if I hadn't felt pushed.

| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |
|---|---|---|---|---|

38. I was given answers but still did not understand the questions.

| All the time | Most of the time | Some of the time | Very Seldom | Never |
|---|---|---|---|---|

39. The course material was presented too slowly.

| All the time | Most of the time | Some of the time | Very Seldom | Never |
|---|---|---|---|---|

40. The responses to my answers seemed to take into account the difficulty of the question.

| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |
|---|---|---|---|---|

41. While on computer-assisted instruction, I encountered mechanical malfunctions.

| All the time | Most of the time | Some of the time | Very Seldom | Never |
|---|---|---|---|---|

42. Computer-assisted instruction did not make it possible for me to learn quickly.

| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |
|---|---|---|---|---|