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AUTHOR	Frick, Theodore W.; And Others
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ABSTRACT

The document presents the executive summary of the final report of Project STEEL (Special Teacher Education and Evaluation Laboratory), a 3-year study at Indiana University. Project STEEL achieved four major goals: (1) development, implementation, and evaluation of a microcomputer-based observation system for codification, storage, and summarization of special education trainees' classroom teaching performances; (2) development, field testing, and evaluation of computer literacy training procedures and materials for preservice and inservice special education teachers; (3) development, implementation, and evaluation of a computer-based testing system for assessing teacher knowledge; and (4) development and preliminary evaluation of a computer-based information management system for storing and retrieving data on special education teachers' performances during their preservice training program. The report concludes that the microcomputer-based observation and feedback system was clearly effective in altering teacher behavior, that the computer literacy training modules developed are an effective instructional package, that the computer-based testing system can help college instructors assess students' acquisition of cognitive objectives, and that the computer-based information management system provides an efficient and secure method for total program evaluation. (DB)

FINAL REPORT

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EXECUTIVE SUMMARY:

A SPECIAL PROJECT TO DEVELOP AND IMPLEMENT A COMPUTER-BASED SPECIAL TEACHER EDUCATION AND EVALUATION LABORATORY

Principal Investigators:

Theodore W. Frick, Lewis J. Polsgrove,
and Herbert J. Rieth

Center for Innovation in Teaching the Handicapped

Dr. Lewis Polsgrove, Director and
Professor, Special Education

School of Education
Indiana University
Bloomington

Project STEEL Final Report

OVERVIEW

This report describes developed products, research, and evaluation regarding the computer-based Special Teacher Education and Evaluation Laboratory (STEEL) at the Center for Innovation in Teaching the Handicapped (CITH), School of Education, Indiana University, Bloomington. Four major goals were achieved in Project STEEL:

I. Development, implementation, and evaluation of a microcomputer-based observation system for codification, storage, and summarization of special education trainees' classroom teaching performances (STEEL/MBOS);

II. Development, field testing, and evaluation of computer literacy training procedures and materials for preservice and inservice special education teachers (STEEL/COLT);

III. Development, implementation, and evaluation of a computer-based testing system for assessing teacher knowledge (STEEL/CBTS); and

IV. Development and preliminary evaluation of a computer-based information management system for storing and retrieving data on special education teachers' performances during their preservice training program (STEEL/IMS).

Comprehensive descriptions of each of these major accomplishments are provided in four separately bound reports (Volumes I through IV, respectively). A fifth separately bound report contains the executive summary of Volumes I through IV, and should be read first.

This document contains the Project STEEL Executive Summary only.

Project STEEL:

Special Teacher Education and Evaluation Laboratory

EXECUTIVE SUMMARY

Introduction

In light of findings from the report, A Nation at Risk, there is need for improvement in teacher education practices, including the training of special educators. More recently, the Holmes Group has suggested a number of reforms in the teacher education process as part of an attempt to legitimize the profession of teaching (Murray, 1986). It appears that there is general dissatisfaction with the quality of public school education, and in turn with the quality of teacher education provided by post-secondary institutions.

At the same time, computer technology has become part of education with the advent of relatively inexpensive computers. An obvious question arises: Are there practical ways that computer technology can be used to increase the effectiveness of teacher training?

Over a decade ago Semmel and his associates (1976) demonstrated that computer-based observation of special education trainees and feedback on their performance was effective in increasing targeted teaching skills two-fold to four-fold (Project CATTS). At that time the computer-based observation and feedback was not cost-effective or transportable, requiring the utilization of an expensive minicomputer. More recently, Semmel and Frick (1982) demonstrated that microcomputers could be similarly used at much less cost (Project CARTLO). However, two problems still remained: the microcomputers were not very portable, and there were questions concerning which teaching behaviors should be emphasized.

Results from a three-year study by Rieth (1983) verified the importance of academic learning time (ALT) for mildly handicapped children and their teachers in special education settings. These results were consistent with earlier findings in regular elementary classrooms with normal children (e.g., Fisher, et al., 1978). Frick (1984) found that a set of teacher behaviors, referred to as direct instruction, was associated with very high levels of mildly handicapped student engagement, whereas non-direct instruction was associated with much lower levels of student engagement with learning tasks. Rieth (1983) also found that lower levels of student engagement were associated with a greater likelihood of poor performance on classroom learning tasks.

Given these previous research and development activities, the need for improving the quality of teacher education programs, and the increased availability of computer technology, Project STEEL was initiated with the major goal of extending the utilization of that technology in the training of preservice special education teachers. This included the development of a computer-based observation system, training special education teachers in the use of computers, development of a computer-based testing system, and development of a computer-based information management system.

Project STEEL Objective #1. The research cited above, along with the commercial availability of truly portable, battery-powered, lap-size microcomputers, became the basis of the first major objective of the STEEL Project. We addressed the central question: If preservice special education teacher trainees are provided with computer-based observational summaries on their use of ALT teaching behaviors during field experiences (e.g., practicums), will they increase their use of these critical teaching behaviors, and will this in turn result in higher levels of handicapped student on-task behaviors?

Project STEEL Objective #2. Although the number of computers in public schools has increased steadily over the past several years (Becker, 1986), availability of computers *per se* is clearly not sufficient for improving the quality of public school education. Effective software integrated with curriculum objectives is necessary, and teachers need to know how to use the computer software effectively with their students. Teacher computer literacy therefore appears to be essential. Moreover, teachers of handicapped students face additional problems when incorporating computers in classroom instruction. These additional considerations need to be addressed in training special educators in the use of computers. Thus, the second major objective of Project STEEL was to develop and evaluate computer literacy training materials and procedures for special educators.

Project STEEL Objective #3. One of the problems cited by the

Holmes Group is inadequate teacher knowledge of subject matter—in content areas that they are expected to teach as professionals. If teacher education programs are going to do something to improve this state of affairs, then they must at least demonstrate that teacher knowledge of subjects they are expected to teach is adequate prior to awarding baccalaureate or higher degrees. Comprehensive testing of teacher knowledge of subject matter is one means of demonstration.

It is true that prospective teachers demonstrate their knowledge of subject matter by taking tests as parts of various course requirements. However, tests and feedback are seldom given frequently in typical college courses. The development, administration, and grading of such tests places additional burdens on instructor time. Instructors are typically not rewarded externally for giving more tests, and indeed may view the prospect disparagingly as it is less rewarding than other activities. Additional testing time also decreases valuable instructional contact time with students—unless, of course, the testing is done outside of regular class meeting times. It would appear that computer-based tests could be part of the solution to this problem, especially in the administration and scoring of tests and in keeping records.

To address the problem of exploring computer technology for administering and grading student tests and for keeping records, the third major objective of Project STEEL was to develop and evaluate a computer-based testing system for use by course instructors and special education teacher trainees.

Project STEEL Objective #4. In an attempt to improve preservice teachers' pedagogical skills and knowledge of subject matter, it was proposed in objectives 1 and 3 above to utilize computers in the teacher assessment process. These solutions will result in a significant amount of information on teacher trainees—particularly if collected over a sustained period of time. The amount of evaluative information collected under objectives 1 and 3 goes far beyond the typical listing of courses taken and grades received. This creates a need to organize, summarize and manage this information if it is to be used effectively in making decisions about the quality of training received by prospective teachers. To this end, the fourth major objective of Project STEEL was to develop a computer-based information management system for use primarily by faculty and administrators, and secondarily by students for reports on their own individual progress.

Summary. Improvement in the quality of regular and special education in the public schools is generally needed. One long-term solution to this problem is to improve teacher education programs so that better qualified teachers subsequently enter the public schools. To help facilitate this process of improvement, we have developed applications in Project STEEL in four major areas of training special education teachers: 1) computer-based observation and feedback on critical teaching behaviors during field-based experiences; 2) computer literacy training; 3) computer-based testing on subject matter knowledge; and 4) a computer-based information management system for special education teacher training programs. These four application areas were developed and evaluated over a three-year period during the STEEL project. The following sections summarize, respectively, the major project activities and results related to the four project objectives. For detailed reporting on developed products and evaluations, the reader is referred to Volumes I through IV, which are bound separately from this summary report.

Objective 1: Microcomputer-Based Observation System

The STEEL Microcomputer-Based Observation System (STEEL/MBOS) was developed to provide feedback to preservice special education teachers regarding their behavior in field settings—e.g., practicums and student teaching. The observational feedback provided in this project pertained to academic learning time (ALT), which has been shown in past research to be related to student long-term achievement (Rieth, 1983; Fisher, et al., 1978). When a preservice teacher was observed during classroom instruction by a supervisor from the teacher education program, his or her behavior and that of students in the class was codified using a modified version of the Academic Learning Time Observation System (ALTOS—Frick & Rieth, 1981). The coding was performed directly on a portable, battery-operated, lap-size microcomputer (Epson HX-20). Immediately after the observation period the supervisors also rated on the microcomputer specific instructional and management behaviors using a checklist comprised of about 65 items. These data were automatically stored on a microcassette at the end of each coding session. The supervisors also wrote field notes pertaining to specific events which occurred during the coding session.

When computer feedback was given, a summary printout was generated on the spot by the microcomputer. As part of the feedback procedure, this printout was given to the preservice teacher along with the hand-written field notes. The supervisor then discussed the printout results and field notes with the preservice teacher, indicating strengths of his/her performance and suggesting areas in need of improvement.

During the third year of the project a controlled study with a lagged replication was conducted to investigate whether or not the computer-based feedback improved ALT (see Volume I). Specifically, we were interested in whether preservice teachers increased the percent of time spent in active instruction and decreased transition time, and if this did occur, whether student engagement rates also increased.

To execute the study, a group of 26 preservice special education teachers at Indiana University were randomly divided into two groups (A & B). During Phase 1 of the study (approximately 8 weeks of baseline), both groups were observed using the STEEL/MBOS. Computer feedback was not given during this phase, but as traditionally practiced, supervisors provided feedback based on field notes taken on student teachers' behavior. An analysis of baseline data indicated no initial statistically significant differences between the groups on the percent of time spent in active instruction, transition and student task engagement.

Between Phases 1 and 2 of the study, preservice teachers in Group A were provided with a three-hour training session on the importance of ALT, the relationship of ALT to student achievement, and the interpretation of the computer data summaries. They also were provided with a teacher's manual which described specific strategies for increasing student engagement and student task success (Frick & Rieth, 1983). Group B received an alternative three-hour training session on humanistic classroom management skills, based on principles from teacher effectiveness training (Gordon, 1974).

During Phase 2 of the study, Group A preservice teachers received computer-based feedback in addition to the field notes. Group B also was observed with the STEEL/MBOS, but did not receive computer summaries. Group B did receive field note feedback as before.

Phase 2 results indicated that Group A preservice teachers significantly increased their percent of time spent in active instruction, compared with Group B. Group A teachers also spent significantly less time in passive instruction and transition activities compared with Group B. Although pupils of Group B preservice teachers significantly increased their active on-task behavior during Phase 2 compared with Phase 1, the pupils of Group A teachers evidenced higher rates of on-task behavior than did those of Group B during Phase 2.

Between Phases 2 and 3 Group B received the ALT training as had Group A earlier. Group A teachers received no further training but were given semester summaries of their STEEL/MBOS results.

During Phase 3 of the study both groups received computer feedback summaries as well as field notes. Phase 3 served as a lagged replication of the Phase 2 results in order to discount threats to external validity such as maturation, learning through experience, historical effects, etc. When comparing Phase 2 vs. 3 only, Group B preservice teachers showed positive changes similar to those observed earlier in Group A. Group B teachers significantly increased the percent of time spent in active instruction and significantly decreased the percent of transition time during Phase 3. Further, no significant difference was observed for student engagement rates for Group B teachers when comparing Phases 2 and 3.

Discussion. The results of this study showed clearly that observational feedback pertaining to specific instructional behaviors, coupled with an explanation of the purpose of such observation, was more effective than a traditional field note feedback approach in increasing preservice teaching behaviors related to academic learning time (ALT). These results indicate that this procedure holds considerable potential for training preservice teachers on a set of critical teaching behaviors related to ultimate student achievement. Moreover, the study indicated that computer-generated feedback, per se, was not effective in altering teacher behavior unless combined with an explanation of a) the purpose of the procedure, and b) the meaning of the specific behavioral categories used in the observation system and their implications for pedagogical practice. Student acceptance of the program changed dramatically when they were provided with specific instructions related to the purpose and utility of the methodology. Results also indicated that the traditional field note approach should not be abandoned, and that a combination of computer-based feedback and field note analysis is ideal both in terms of increasing teaching effectiveness and in enriching preservice teachers' understanding of the complexity of the instructional environment.

The current results, albeit encouraging, must be weighed in terms of a cost-benefit analysis of the total training program. Some of the costs of the STEEL/MBOS involve data storage and transmission, observer training and calibration, and acceptance of the procedures by supervisory personnel.

First, the STEEL/MBOS entails the collection of a considerable amount of observational information related to preservice teacher performance in field se ngs. This poses problems of data storage and analysis. The lap-helc .rocomputers store data on a microcassette. These microcassettes must be periodically collected and information on them transmitted to a larger computer database. Data may be aggregated through various retrievals from the database to provide semester or annual summaries on each preservice teacher, as well as summaries across all teachers in the program during some period of time. The latter information may be useful in making decisions regarding the overall effectiveness of the teacher training program (see Volumes I and IV of this report for examples of output from such retrievals). This process requires personnel time at each step—data must be transmitted from the microcassettes to the larger computer system, and retrievals from the larger database need to be perfomed. The expense and time spent on data transmission, storage, retrieval and analysis must be weighed against the utility of the information for evaluating student performance and overall program effectiveness.

A second consideration in evaluating the benefits of the STEEL/MBOS concerns the cost in time and energy related to observer training. Approximately 15 to 20 hours were required to train observers to reach an acceptable level of competency for field placement. Moreover, an additional four hours per observer were required to calibrate skills. The costs of training and maintaining observers' skills must be weighed, especially if a new group of observers must be trained annually. A further consideration related to observer training concerns the potential stress that some observers may experience when learning the procedures and reaching an acceptable criterion.

Other factors to consider include the perceived inconvenience of the computers. Despite their compactness, the computer's weight (about seven pounds) was burdensome to some observers. Computer batteries must be regularly re-charged, and if not done properly, can result in occasional losses of data. Further, the noise of the computer-resident printer required supervisors to retire to isolated locations to make printout summaries in order to avoid disruption of on-going classes.

A final consideration in evaluating the efficacy of an approach such as the STEEL/MBOS concerns the general perception of supervisory staff regarding the role of technology in the training program and the usefulness of the database. In this study the observers were generally positive regarding the methodology after the purpose of the program was explained to them and they observed the changes in preservice teacher performance. However, the supervising faculty member viewed the methodology as an irrelevant departure from a field note feedback procedure which she had previously developed and refined. The additional demands on time and inconvenience in managing the methodology were seen as prohibitive for this individual. She also remained skeptical of the usefulness of the observational information for program evaluation compared to traditional information sources. Thus, although the methodology proved effective in positively influencing important preservice teacher behaviors and maintaining a record of these, acceptance of the program by key staff members as a viable alternative to traditional teacher training procedures remains a critical factor in its potential adoption and implementation in a teacher education program.

Objective 2. Computer Literacy Training

A second for accomplishment during the first year of the STEEL project inv ne development and pilot testing of a computer literacy training package (STEEL/COLT) for special education teachers. The COLT modules were designed to be integrated in a college level teacher education course. They c ntain lecture notes for course instructors, printed materials for students, microcomputer software, and transparencies. In addition, test items are included for assessing learner acquisition of knowledge and skills taught.

In developing the content for the STEEL/COLT modules, one of the initial tasks undertaken by the project team involved identification of preliminary instructional objectives for the computer literacy training component. After appropriate major objectives had been identified, the staff conducted a literature search related to those objectives. The search at that time revealed little available research information concerning computer education of teachers, and virtually none related to the needs of special educators. Thus, much of the material for the modules was drawn from the general literature, from past research done at the Center for Innovation in Teaching the Handicapped (CITH), and from tapping the human information resources available within the project staff. Eight modules were then developed. The final versions of these modules are presented in their entirety in the separately bound Volume II of this report.

Evaluation. To formatively evaluate the STEEL/COLT modules, a special education course was offered for credit on the IU Bloomington campus during the summer at the beginning the second year of the project. A total of 20 students were enrolled in this course, all of whom were graduate level and taught during the school year. Students received over 56 hours of direct instruction (two 3 1/2 hour classes each week for eight weeks) in the form of lecture/demonstrations, discussions, and hands-on applied experiences. The hands-on experiences constituted approximately 30 hours of open-lab, tutorial sessions. Instruction was provided by a member of the graduate faculty of the Department of Special Education with assistance from CITH's professional staff.

The two major brands of microcomputers mostly l' ly to be found in

Indiana schools at that time were the Apple II and Tandy-Radio Shack TRS-80. These were made available in sufficient numbers for use by the participants by drawing upon CITH equipment resources and those of the School of Education. Information was also provided regarding other major brands of computers (e.g., IBM PC) to which the students might have access, and differences among the various models were discussed when appropriate.

Evaluation of the STEEL/COLT modules used in the course consisted of: 1) an assessment of changes in student attitudes toward microcomputers as a result of participating in the course; 2) a determination of student mastery of the course content; and 3) a survey of students' satisfaction with the training experience. These results are discussed in detail in Volume II of this report, and only will be summarized here.

As a result of participating in the course, individuals apparently gained confidence in their ability to write programs, choose commercially available software, and use microcomputers effectively in special education classrooms. Their responses further revealed that their attitudes regarding the effects of computers on society became less negative. Students also became more critical and less satisfied with the instructional value of available software (and rightly so).

Pre- and posttest versions of a mastery test covering module content were administered at the beginning and end of the course in which the STEEL/COLT modules were used. Despite the fact that the mastery posttest was designed to be much more difficult than the pretest, there was a highly significant gain in knowledge, indicating increased computer literacy.

Students were highly satisfied with most parts of the course and the eight modules. They were especially appreciative of the significant amounts of guided hands-on experiences provided. Suggestions for improvement of the course and the modules were solicited in addition to the above evaluation information. Taken together, these results guided subsequent revisions of the modules.

During the summer beginning the second year of the STEEL project, the course was taught again, using the revised versions of the modules.

Similar evaluation activites and results were obtained as described above. See Volume II of this report for details.

During the third year of the STEEL project, one module was selected for further development in response to teachers' evaluations during the previous two years. The SuperPILOT authoring language section (Module 5) was considerable revised and extended, then was formally tested and evaluated once more during an intensive workshop near the end of the third year of the project. In total, more than 60 teachers were trained over the course of the STEEL project regarding microcomputer applications in special education classrooms.

In summary, the eight STEEL/COLT modules, when used in conjunction with a graduate level course in computer literacy for special education teachers, appeared to be very successful in producing positive changes in attitudes toward computers, in helping students master course content, and in leaving students feeling satisfied with the course.

A note of caution for one interested in adopting the STEEL/COLT modules and who is not highly experienced with using computers in education: He or she would be well advised to take such a course first as a student before trying to teach it. Alternatively, if one is able to learn well alone, it would be advisable to provide at least two semesters of lead time to prepare for teaching these materials.

Objective 3: Computer-Based Testing System

During the first year of STEEL, most project resources were allocated to development and implementation of objectives 1 and 2 as described above. Considerable time was spent, however, in specifying the design of the computer-based testing system, evaluating and selecting hardware and software for development of the testing system, and preliminary experimentation with kernel routines that the testing system would be built upon.

For the second year of the project, Version 1.0 of the STEEL Computer-Based Testing System (STEEL/CBTS) was developed and debugged. During the summer of the beginning of the third year, initial pilot testing of the STEEL/CBTS was undertaken with students in the STEEL/COLT course and another graduate level course taught by one of the principal investigators (i.e., students took their mastery tests using the STEEL/CBTS). Further pilot testing and revisions of the STEEL/CBTS software continued during that year and a research study was conducted to test the predictive validity of an adaptive testing strategy that was included as part of the testing system.

Formative evaluation indicated that the testing system worked reliably, as planned, with over 400 successful test administrations to date. Security of test item pools and databases for storing test results was never violated insofar as could be detected. After initial debugging of a rare minor problem, no data on test results have been lost. Response times for item presentation and answer judging were excellent in a time-sharing environment—even with a relatively large number of heavy users. Answer judging was completely reliable for all alternative response items (i.e., multiple-choice, true-false), and reliable almost all the time for constructed responses (i.e., fill-in-the-blank, short-answer)—the latter depending on the test developers' answer judging specifications. The adaptive testing strategy proved to be highly reliable, while reducing test taking time an average of 75 to 80 percent.

Formative evaluation also revealed the need for revising parts of the STEEL/CBTS, adding options not present in Version 1.0 and making the STEEL/CBTS more friendly to instructors when developing test item pools and retrieving test results. It was not possible, however, in the time frame of the current project to embellish the STEEL/CBTS software. Formative evaluation also indicated some hesitancy by faculty to use the STEEL/CBTS. The need for a regularly available, easily scheduled, supervised testing site also was identified.

A description of the testing system and results of formative evaluation are presented in the separately bound Volume III of this report.

STEEL/CBTS design considerations. The following parameters were considered for the design and subsequent development of the STEEL/CBTS:

1. The testing system was made highly secure from unauthorized access, so it can be used for formal evaluation and grading purposes.

2. The testing system was configured to be highly reliable. Not only does it work correctly, but it also does not lose or mix up data.

3. The testing system was designed for easy access from various locations on campus, provided that authorized access is permitted.

4. The testing system was developed to be flexible for instructor creation of a great variety of test item formats. It is possible and relatively easy to develop test items locatable anywhere on the display that utilize: a) high-resolution color graphics; b) different sizes, fonts, slants and rotations of text; c) instructor-determined answer judging criteria regarding spelling, capitalization, punctuation, extra words, word order, synonyms, noise words, and alternative correct and incorrect responses; and d) answer formats that include constructed responses, as well as multiple-choice, true-false, and fill-in-the-blank formats.

5. The testing system can administer items by a variety of methods—e.g., conventional fixed length tests with items in a predetermined sequence, conventional tests with random item selection, and adaptive testing strategies—without changing the items themselves.

6. The testing system was designed so that it can be extended relatively easily by competent professional programmers. The source code is modularized and documented within.

7. The testing system was configured to run on computer systems commonly found on college campuses, ranging from relatively small and inexpensive to large and expensive systems—without any modifications in the code.

8. Parts of the testing system are not independently executable, unless the context is exactly correct (i.e., without other complementary parts present and in the "right" places). For example, if someone were able to obtain an executable copy of a test item pool, the copy could not be successfully run by itself, and would be otherwise unintelligible.

9. Parts of the testing system can be decentralized in the computer's directory and accounting structures, so as to make it extremely difficult and time consuming to discover the locations of all the pieces—i.e., to minimize vulnerability to accidental discovery, intentional theft, or sabotage.

10. The size of the testing system and item pools is not limited by physically available computer memory. A virtual memory computer system is therefore required.

Software and hardware considerations. Given the above design specifications for the STEEL/CBTS, software possibilities were next investigated. It was concluded that in order to maximize flexibility of item development by instructors, a good authoring language was needed. We chose to go with an authoring language for instructor test item development, since this would maximize flexibility and power. We expected to develop authoring aids for instructors to minimize their learning time (i.e., templates for typical item formats). We also expected, wherever possible, to take advantage of existing instructional materials and computer-assisted instruction on the language itself and various editors required to develop text files, graphics, and character fonts.

Before settling on a choice of an authoring language, hardware possibilities were next investigated. Microcomputers were rejected because they typically lack the computing power and size required for the resident, centralized testing system. Although some microcomputers can be networked and support time-sharing, none that we could find supported virtual memory operating systems or had adequate CPU speed to handle more than a few users at once. For security, memory and record keeping, the best choice appeared to be minicomputers with virtual memory systems, that maintain upward and downward software compatibility across various sizes and models, and that are commonly found on college campuses.

One computer system was identified which met all of the above criteria: VAX supermini's, mini's, and supermicrocomputers (Digital Equipment Corporation). The VAX series all run compatible versions of the VMS operating system and are virtual memory machines; they can be flexibly configured depending on anticipated usage.

After selecting a hardware system, we next considered authoring languages that would run on VAX's. Here our choices were restricted at that time—either DAL or Producer. Though the Producer was somewhat more friendly as an authoring environment, and frequently used for in-house development at DEC, its response judging capabilities were relatively primitive and unsatisfactory for our purposes. This left the Digital Authoring Language (DAL), which is a highly structured language, contains instructions for creating high-resolution, color text and graphics, and has very flexible and powerful response judging capabilities. DAL is also accompanied by a reasonably good graphics editor and character set editor. VMS supports a very easy-to-use text editor (EDIT/EDT), similar to a word processor, for developing and modifying source code. Furthermore, there is computer-assisted instruction available on DAL, VMS and EDIT/EDT.

A disadvantage of DAL is that all text/graphics output is coded in ReGIS (Remote Graphics Instruction Set). This means that test items developed in DAL can only be run on workstations or terminals capable of interpreting ReGIS, such as GIGI and VT240 terminals.

Selection of DAL was not a perfect solution, but, in our opinion, it is the best currently available authoring language for the VAX series. We believe that the advantages of DAL significantly outweigh the disadvantages.

Despite considerable advances in microcomputer technology in the last five years, microcomputers were considered infeasible delivery systems for the STEEL/CBTS. The major disadvantages of microcomputers involve limitations in networking capabilities, de-centralization of record keeping, and greater problems with security and management of test item pools and data on test results. For example, to operate the system, multiple disk copies of the same test must be made to test a group simultaneously. Separate data disks need to be maintained for each simultaneous user, and then these separately recorded results need to be subsequently aggregated into a master file on a hard disk from each of the individual floppy disks. There is considerable room for error in the human management of this process.

Furthermore, the use of microcomputers carries considerable risk in loss of data. Microcomputer test takers can defeat the data storage process during or after a test by removing data disks during a disk write operation, by failing to latch disk drives, or by turning off machines during disk-write operations. Lastly, the use of microcomputers would restrict the size of the test-item pools due to limitations of physical memory in individual microcomputers.

The problems inherent in the use of microcomputers for the STEEL test program were avoided by using a VAX mainframe environment which allowed centralized testing and record keeping, multiple testing site options, simultaneous administration, unrestricted item pool and data storage, faster test administration and information retrieval, and simplified and more secure data security and management.

Development of the STEEL/CBTS. The STEEL/CBTS was developed as a set of DAL programs integrated by VMS DCL command files. One of the programs (AUTHOR) performs various security checks, and if the student passes them, allows the selection of a test from a menu provided for a given course and section. If an instructor has authorized access to the test chosen at that time, control is next passed to Program TADMIN, which administers the test according to criteria and methods set by the instructor in advance. Program TADMIN also keeps complete records on every item administered during a test, as well as summary records for each administration.

Two utility programs were developed as part of the STEEL/CBTS for use by instructors. Program VALIDATE checks the integrity of registration files created for courses and sections by instructors. These registration files contain student identification information, personal passwords, grading criteria, test identification information, methods of administration, test passwords, and date/time slots for when tests can be taken. Program DBMSSTEEL allows course instructors to retrieve test results for individual students or all students registered in a given course and section. These results can be output in screen or hardcopy formats. Most importantly, the instructor can dump the database into a sequential file format suitable for input to almost any DBMS or statistical package.

Over 11,000 lines of DAL code were written for these four main STEEL/CBTS programs.

Use of the STEEL/CBTS by students. A detailed description of the STEEL/CBTS with sample screen displays observed by students is provided in Volume III of this report. To access the system a student sits at a terminal and logs onto the VAX computer where the testing system resides. Next, she or he enters identification, course, and section numbers. If registered in the testing system for that course/section, the student must next enter his or her personal password to continue. If the password is correct, a menu of tests is displayed. Having chosen a test and if authorized to take it at that time, the student must then enter the current test password.

When the student passes all these security checkpoints, the chosen test is begun. After a welcoming message, general test directions are presented on how to answer questions, how to correct typing mistakes, and how the test will be administered. Test items are then presented one at a time. At the end of the test the student is informed of the number of correct and incorrect answers and the decision outcome associated with that score (e.g., pass/fail, a letter grade, etc.). The student can optionally review his or her answers to items missed on the test, but cannot review test items themselves. Finally, a parting message is displayed and the student is logged off the computer.

Summary. Considerable field testing of the STEEL/CBTS indicated that it did work reliably. No data were lost during formal testing, and the security system worked satisfactorily. Most of the important evaluation results from field tests were discussed earlier and further detail is provided in Volume III. While a number of embellishments could be made in the STEEL/CBTS to make it more convenient for users, cessation of the project precluded these. Further funding may be sought to support refinement and expansion of the system.

Objective 4: Computer-Based Information Management System

The discussion of objectives 1 and 3 indicated that significant amounts of assessment information can be obtained on preservice special education teachers concerning their demonstration of pedagogical skills in field experience settings and knowledge of subject matter relevant to their teacher education program. Thus, there was a need to organize, summarize and manage this information for purposes of decision making regarding preservice teacher proficiencies.

To this end, the computer-based STEEL Information Management System (STEEL/IMS) was developed. The STEEL/IMS was designed for storage and retrieval of observational data, test results, student background information, and other data pertaining to student progress in the special education program. The primary use of the STEEL/IMS was intended for faculty and administrators in advising students, tracking student progress, and in making recommendations concerning graduation and subsequent job applications by teachers. The secondary use of the STEEL/IMS was intended for preservice teachers in the program, so that they could, upon proper identification, access their personal records in the database.

During the first year of the project, design parameters were specified for the STEEL/IMS, and hardware/software characteristics were considered. During the second year, a prototype system was developed using an information management system called the Scientific Information Retrieval Database Management System (SIR DBMS). This prototype was used to store and retrieve observational data collected on teacher performance during field experiences and teacher background information. During the third year, the STEEL/IMS was revised and further extended by adding the capability of storing and retrieving test data obtained from the STEEL/CBTS, and by adding an electronic mail system for communication among faculty and students in the special education program.

The STEEL/IMS was designed to provide menu-driven on-line help at almost every response point in the program. Volume IV of this report provides a detailed description of the software and sample screen displays for typical user sessions.

Formative evaluation of the STEEL/IMS indicated that the software performed remarkably well. Input of data records, storage, and a variety of retrievals were accomplished quickly and without error. The security system of the STEEL/IMS is very sophisticated and permits different levels of access to specific records, depending on the security authorization level of a user. Each user is availed to various levels of the database through personal passwords. This security system was easy to do in SIR DBMS, since these features are built into the software system. The STEEL/IMS was extensively formatively evaluated and subsequently revised during in-house testing. It was completed and ready for use by faculty near the end of the last year of the project. Unfortunately, because of the extensive time spent in development and limited faculty time, little information regarding user interface issues could be collected before the project terminated. To maintain and update the STEEL/IMS a person must be responsible for managing the system who has some familiarity with the SIR DBMS language. Clerical assistance is also needed for data input—e.g., transmitting computer-based observational data from the microcomputer to the STEEL/IMS, entering student background information, and entering information on results from tests not administered by the computer-based testing system.

Design considerations. Many of the same design principles that were used in developing the computer-based testing system described earlier were also considered for the STEEL/IMS. The major exception to this is, of course, difference in the purpose of the IMS. We concluded, as we did for the testing system, that security, reliability, centralization of record keeping, and ease of access was maximized if the STEEL/IMS resided on a single computer. Thus, the VAX environment, which supports a time-sharing system and is networked to workstations available at many different campus locations, was selected to support the STEEL/IMS.

Hardware/software considerations. Microcomputers were not totally discounted as resident machines for the STEEL/IMS, primarily because at any given time there would only be a few simultaneous users of the STEEL/IMS, unlike the situation during group testing. However, a very powerful micro would be required to operate the system, with at least one-half megabyte of internal memory and 20 to 40 megabytes of secondary storage on a hard disk, with a high-speed tape backup system. These conditions would also be easily met by typical minicomputer and mainframe systems.

Use of the STEEL/IMS. Detailed descriptions and examples of screen displays and retrieval outputs are provided in Volume IV of this report. Only a brief description is provided here. To access the STEEL/IMS, a user first logs onto the computer and then starts the program. Second, she or he is presented with a brief welcoming message and asked if an introduction is wanted (for first-time users). If so, a brief explanation of the STEEL/IMS is provided, and conventions are explained on usage (e.g., how to exit some process, get help, correct typographical errors, etc.). Third, the user is queried about the kind of terminal or workstation being used, so that screen output can be tailored to that device. Database security clearance is then checked. The user is asked for his/her STEEL/IMS user name and password. This prevents unauthorized access and also determines the security level clearance for how the system can be used. For example, a faculty member will see one kind of menu of functions that can be performed in the STEEL/IMS, whereas a student would see another menu.

Only someone with system manager privilege would see the most extensive menu which permits actual modification of the database (see examples of screen displays in Volume IV). If accessed by a faculty member, for example, the STEEL/IMS functions would include the following:

1. Access the mail service.
13. Report the student profiles.
31. Summarize a student's observation data.
32. Summarize a student's checklist data.
33. Summarize each student's observation data.
34. Summarize each student's checklist data.
35. Summarize all student observation data.
36. Summarize all student checklist data.
41. Report a student's test data (by course/section/objective).
42. Report each student's test data (by course/section/objective).
43. Analyze test items (by course/section/objective).

If the STEEL/IMS were accessed by someone with system manager privileges, the menu includes all of the above and many more functions on managing the database (e.g., purging student profiles, adding observation data, storing the database on magnetic tape, printing the access log, etc.).

Each STEEL/IMS retrieval can be delimited by date ranges and other criteria. For example, a faculty member may want to retrieve an observational data summary on student X during his senior year only. Or, he or she might want criterion-referenced test (CRT) results on all students in a course or section that were administered during the fall semester. Depending on how extensive the output from a retrieval is, it can be viewed on the terminal display or routed to a nearby high-speed printer for permanent hardcopy.

In summary, the STEEL/IMS permits a variety of ways of retrieving information on students in the special education program. Security is excellent, and database functions are limited by the type of security clearance one has been assigned.

Summary

The central goal of Project STEEL was to utilize computer technology in ways that could facilitate the process of training special education teachers. If teachers are better prepared by their training programs, we would expect that they would do a better job of teaching in the public schools than is now occurring.

Over a three-year period Project STEEL staff developed, implemented and evaluated technological applications for use in special teacher education programs. Four major objectives were accomplished: 1) the Microcomputer-Based Observation System for providing feedback to preservice teachers during field experiences, 2) Computer Literacy Training for special educators consisting of eight modules for use in a college level course, 3) the Computer-Based Testing System for assessing preservice teacher knowledge of subject matter and 4) the Information Management System for storing and retrieving information on students in the teacher education program.

In project STEEL, we feel we have advanced the field by creating a prototypical computer-based system which facilitates preservice and inservice teacher training. The microcomputer-based observation and feedback system developed on this project was clearly effective in altering teacher behavior in training environments. The computer-based testing system offers college instructors a powerful aide for assessing students' acquisition of cognitive objectives in their courses and for providing them feedback on their progress. The computer-based information management system provides an efficient and secure method for total program evaluation. Finally, the computer literacy training modules offer an effective instructional package for training special educators to use microcomputer technology in special education classrooms for mildly-handicapped youngsters.

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