ISOLATED RURAL SCHOOLS CAN HAVE COMPUTERS AND TEACHERS WHO CAN UTILIZE THEM

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The development, operation and evaluation of a federally supported (National Science Foundation Grant SMI77-13063) program to develop teachers trained in computing and its application to serve as computer resource persons in their local schools is described. The need for such a project is delineated as partial motivation of the work reported. From this the objectives and project operational plan are established. The financial support mechanism is discussed. The actual operation and evaluation are described and conclusions are drawn.

Key words: High school computer user; high school teacher training; rural schools

1. Introduction

The purpose of this paper is to report on a rather innovative project used to assist in the development of computer science teachers and computer resource persons at the high school level in the State of Wyoming. The project, which received support from the National Science Foundation under grant SMI77-13063, was implemented during the 1977-78 school year. This paper will first describe some perceptions of the problems which were attacked Next, some background information on the need for such a project will be presented. The proposed solution to this problem and the meeting of the needs of the state led to the development of the objectives to be met by the project. Next, the plan of the project and institutional strength will be discussed. The mechanism used for support will be discussed. Finally, the operation and evaluation of the project will be described. This report is being presented not only to disseminate the knowledge that was gained from this endeavor in the hopes that it may help other computer science educators to advance the cause of computer science, but also because this project indicates that the previously existent lack of communication between college and high school level educators has, in Wyoming at least, been successfully bridged.

2. The Problem

The computer science faculty at the University of Wyoming have observed and stated that students entering beginning computer science courses at the freshman level (required by many departments in the University) seem to exhibit a lack of awareness of algorithmic methods and a lack of problem solving ability. This observation indicates that even college bound high school students are not being adequately prepared in scientific thinking [3].

The State of Wyoming, at the present time, does not have a comprehensive computer educational program in the high schools. At present, there are only three high schools within a 100-mile radius of the University that have initiated a limited computer science program. They currently use the University main-frame via telephone line hook up to teletype oriented terminals.

3. Outline of Needs

One of the basic issues facing secondary schools today relates to the role of the computers in the school program [2, 4, 6]. Should math teachers teach computer programming? Should there be a special elective course on computers, or should computer science be included in regular mathematics, chemistry, business or science courses? Should the computer be used as a tool for solving problems? What kind of equipment must be made available for student use? Should the school purchase a low-cost computer, or should it lease computer time from a time-sharing network? Who should assume responsibility for teaching the role of the computer in society? Although there are many questions and indecisions regarding the use of computers in secondary schools, educators realize that computers are here to stay. Numerous inquiries have been received from teachers and school administrators with respect to a computer education program for teachers.

It was felt that a project of the type described herein could help to eliminate the frustration felt by these teachers and school systems in attempting to answer these questions.

The educational benefits of computer technology are many, though they are not readily available and accessible. In the case of Wyoming and much of the surrounding area, geography has dictated that distances between towns is often over 80 kilometres (50 miles), and realistic proximity to a major university does not exist. In fact, there are entire counties with no population center of over 1,000 people. This distance determines the small isolated communities that exist and explains why it is a major difficulty for the people in our service area to have access to meaningful communication with anyone knowledgeable in computer technology for education. Since this distance barrier exists, we felt it would be of greatest benefit to take the training to the participants where they can learn computer programming techniques, and learn about and participate in recent innovations in computer technology. This was justified on a cost effective basis as, in the long-run, being more economical than transporting numerouse teachers to the University from great distances [8].

In December of 1976, a committee of Wyoming high school mathematics teachers writing the objectives for the Wyoming Mathematics Needs Assessment included a computer awareness section. Even though this committee stated that the section on computer awareness was not to be tested at this time, it is clear that computer technology is a concern of mathematics educators. Furthermore, the committee indicated that computer awareness would be tested whenever school systems have personnel qualified in computer education who are capable of teaching computer science and computer related courses [1].

4. Objectives

The computer is becoming part of more and more facets of everyday life and, hence, is influencing the society for which the school is preparing its pupils. Computing techniques, algorithmic methods and the elements of computer science are being found to have a place in secondary teaching, either in their own right or as an adjunct to other studies in the curriculum [5, 7]. The computer provides a flexible and powerful tool for use in the school, both as an instructional medium and as an aid to educational administration.

The computer, used as a tool of instruction and a subject of instruction, can help convert routine courses into exciting experimental subjects. Some of the objectives of teaching about and with computers in the secondary school are as follows:

- To develop student appreciation of the computer's role in society.

- To remove the mystery and bewilderment that may exist in the student's mind about computers and automation.

- To enrich existing programs through use of the computer. Allow students to work on creative and complex problems that would be impossible to solve by manual methods.

- To motivate students and teachers to more individual, challenging instruction.

- To develop the student's abstract reasoning ability and general problem solving skills. To teach him algorithmic thinking and explore rigorous thought processes.

- To encourage students to apply computer concepts creatively to a variety of application areas.

- To better prepare college bound students with an understanding of the computer and how it can and cannot be used to solve problems.

Hence, as a result of the above, we can state the objectives of this project:

(a) To provide participants with a strong background in computer programming techniques--with emphasis in the BASIC language--so that the participants will be equipped to teach computer programming in their school.

(b) To introduce participants to recent developments in the usage of computer technology in educational systems.

(c) To provide a computer facility to allow exploration of computer technology in the individual setting of the participant's own school.

(d) To train a participant who can act as a resource person to aid in administrative decisions with regard to computer technology in the local school system.

5. The Plan

5.1 The Plan of Operation was Divided into Three Segments

Segment 1 would consist of a one-week intensive training session during the Summer of 1977 for a maximum of 20 participants. This segment would include instruction in computer programming techniques and would be used to introduce participants to recent developments in computer technology. Included would be a detailed look at computer applications with respect to both hardware and software.

Segment 2 would consist of each participant having access to a minicomputer system (the cost of which would be shared between the school district and the companies providing the machines) for a period of two weeks on a rotating basis. Preliminary contacts to school districts and minicomputer suppliers had produced encouraging responses. During that two-week time period, a participant could use the minicomputer system to teach programming techniques to students in his/her school, further develop his/her own techniques, and become prepared to act as a resource person in his/her home locale. Included in this segment would be direct participation by the project staff. A staff member would deliver the system, make sure it was operable, teach secondary school classes as needed, and teach an in-service class in computer technology if requested. Furthermore, the staff member and participant would spend two days during which the staff member could provide individual instruction to the participant. The participant would serve as coordinator in establishing the best use of the staff member's time during this visit.

Segment 3 would consist of one staff member being on call at all times at the University to provide assistance to participants or their administrators. This most likely would take the form of technical questions concerning either hardware or software problems and coordinating the transportation of the minicomputer system but might also include administrative questions concerning budgets and hardware.

5.2 When and Where it Would Have Taken Place

With respect to the segments mentioned above, Segment 1 would be conducted August 15, 1977 to August 19, 1977 at the University of Wyoming. That week was the last full week of summer before school started in the fall.

Segment 2 would be conducted throughout the school year, 1977-78, on a rotating basis, allowing two weeks for the minicomputer system to be used in each participant's school. Fifteen participants was the number which could be accommodated during the academic year.

5.3 Characteristics of Participants Expected

We expected the participants would be experienced high school science or mathematics teachers who were interested in teaching computer programming and related topics, but who had little or no knowledge in this field. Due to the geographical limitations, we proposed to limit this program to participants from Wyoming school systems.

5.4 Format and Instructional Mode to be Used

The instructional mode would consist of lectures and laboratories. The lectures would be devoted to instruction in algorithmic methods and the BASIC language, while the laboratories would involve participants utilizing the knowledge from the lectures while interacting with the University's time-sharing computer facilities and the minicomputer system.

Time allocations for the eight-hour day during the summer session would be as follows:

1 hr. lecture in programming techniques
2 hrs. laboratory and discussion
1 hr. lecture in applications and innovations
1 hr. lecture in programming techniques
2 hrs. laboratory and discussion
1 hr. daily summary and problem discussion

With the development of a short teaching activity and successful completion of Segments 1 and 2, the participant would be awarded two hours graduate level University credit.

The instructional techniques of Segment 2, of necessity, would vary according to the needs of the individual participant. The techniques used to benefit the participant might include having the staff member teach a secondary school class using the minicomputer. However, most instruction in Segment 2 would be in an individual manner and involve laboratory work with minicomputer.

5.5 How the Overall Project Operating Plan was Designed to Achieve the Project Objectives

Segment 1 was designed to provide participants with a strong background in computer programming techniques needed to teach programming at a high school level and to provide participants with knowledge of recent developments in computer technology in educational systems.

Segment 2 was designed to provide a computer facility to allow participants the opportunity to explore computer technology in their schools.

Segments 1, 2 and 3 were geared to provide participants with information necessary to act as local resource persons.

5.6 Participant Selection Procedures

The project would be advertized in the form of an announcement sent to all of the science and mathematics teachers in the state as well as the school systems' administrators. Included with this announcement would be a return portion soliciting candidates. Preliminary inquiries had indicated that this would have yielded a more than adequate number of candidates.

Candidate selection would be made by the following criteria:

1) Interest in teaching computer programming and related topics;

2) Science and/or mathematics teaching experience; and

3) Recommendation and financial commitment from school administrator.

Geographic distribution would be observed as well as equal opportunity and affirmative action criteria.

5.7 Institutional Strengths, Experiences and Facilities

The creation of the Science and Mathematics Teaching Center to serve the in-service needs in Wyoming and the Rocky Mountain Region, and the resulting success indicated that it was the appropriate body to conduct the project. The Science and Mathematics Teaching Center, with Andrew A. Aronson as Associate Coordinator, had been instrumental in the development and implementation of a highly successful innovative program of in-service education for teachers. This program, "The Portal School Program," had been utilized by hundreds of school systems in the Rocky Mountain Region and had offered teacher in-service to over 9,000 teachers since 1971. Recent NSF funded studies by the Minnesota Research and Evaluation Project reveal that the "Portal School" program had a high efficiency rating related to the persistence of curriculum implementation in the schools while being the most cost effective program of its type in the United States [9]. The high standards of program development the Science and Mathematics Teaching Center applied to the development of the "Portal School Program" would be applied to and form a basis for this project.

In that respect, the Science and Mathematics Teaching Center has always been willing to support activities that lead to continuing education and as such has accumulated knowledge and materials for implementation for in-service work. Similarly, the idea of the Science and Mathematics Teaching Center being the leader in innovative in-service Mathematics education has been accepted by the University faculty and new projects are encouraged. This joint venture with Computer Science was indicative of the spirit of cooperativeness to provide the best educational opportunities for educators in our service area.

The Computer Science Department was growing and was deeply committed to providing training in computing to not only the University community, but also to all educators in Wyoming. They had modern equipment and the technical expertise to provide support over and above the explicit manpower commitments.

In addition, the Division of Computer Services at the University would make the University computer available to the project.

6. Support

Support for the project came from many sources.

Initial planning was carried out by a committee representing the Computer Science Department, the Science and Mathematics Teaching Center (SMTC), and the Wyoming Mathematics and Science Teacher's Association (WMSTA). This committee formalized much of the information already described. A proposal for funding to operate such a project was developed and forwarded to the National Science Foundation. The outgrowth of this proposal was a blend of funding from a variety of sources as described in table 1.

Component	Funding Agents	
Participant Support for Short Course	NSF	80%
	Participants	20%
Tuition and Fees for Participants	UW	100%
Staff Travel Incident to the Project	NSF	100%
Minicomputer Rental	Local School Districts and WMSTA	90%
	Vendor	10%
Project Staff	NSF	75%
	UW	25%
Computer Time for Short Course	UW	100%

Table 1. Funding Sources

7. Project Operation

Applications were solicited and screened during late summer 1977. The 20 participants were selected and notified. Due to funding difficulties (the funding arrangements were not finalized until less than a month before operation started), the timing was such that the participants were stratified in two fashions.

The first stratification was that five of the participants had computers available for student use, and, thus, those participants were not serviced with the two-week project computer segment, although we did attempt to perform the site visit function. The second stratification was on the level of experience. Several participants had either some formal training or informal training in computer science. Though neither of these stratifications had been anticipated, both proved beneficial. With only 15 schools to serve, we were able to schedule the home site computer usage portion for two weeks of class time while students were at the school rather than overlapping with Thanksgiving, Christmas, spring vacation, and other holidays. The second stratification also proved beneficial insofar as the staff was able to run parallel complementary training sessions rather than overlapping the presentations.

The short course included the following activities and/or presentations:

1) Advanced Algorithmic Techniques
2) Beginning Algorithmic Techniques
3) State Funding Sources (State Department of Education)
4) Teaching Methods
5) Applications Outside Science and Math
6) Vendor Presentations
7) Site Visit to Local High School Facility
8) Books
9) Audiovisual Services
10) Hands-on Computer Work
11) Dealing with Administrators and Boards of Education
12) BASIC Language
13) Participant Selected Topics
14) Evaluation of the Short Course
15) Careers in Computing

The site visit and school computer usage components were quite varied and interesting. Despite minor transportation problems (closed roads, icy conditions, ground blizzards, 500-mile trips in one day, and the like), minor equipment problems (horizontal hold adjustment, a slightly flaky cassette drive, and miscellaneous tape stretching and erasing), and the resultant exhaustion of the staff, the site visit component went pretty much as planned. The most consistent feature of the site visits was their inconsistency. No two were the same. Several of the more usual activities included:

a) Presentations to teachers other than the participant.

b) Presentations to school boards.

c) Presentations to service clubs.

d) Presentations to classes.

e) Development of teaching outlines.

f) Evaluation of equipment proposals.

g) Discussion with administrators.

h) Booing of the staff by students when they picked up the machine at the end of the two-week period.

There were several very unusual activites which occurred during site visits:

a) A chance for students at one school to implement identical algorithms on both the project mini and a programmable calculator.

b) Use of the mini to help score a gymnastics meet.

c) Presentation to the local law enforcement agencies.

d) Presentation to local groups of retarded citizens.

e) An informal contest between schools with each successive school attempting to outdo the previous schools in the development of programs which were fun to use.

f) An ad hoc course on computer repair (when the tape handler was replaced).

Segment 3 was used quite a bit and the inquiries were quite varied, ranging from requests for self-paced books for students to specific questions involving how to solve particular problems to proof reading and making suggestions regarding computer equipment proposals.

8. Project Evaluation

Two evaluations of the project were made. The first was after the one-week short course, and the second was a summary evaluation after completion of the school year of the site visits. The delay until the end of the school year for the second evaluation was to allow the participants to view the project in perspective rather than to allow immediate enthusiam to influence the evaluation. In both cases, the evaluation was on a five point scale as follows:

1) Strongly Disagree or Strongly Negative

2) Disagree or Negative

3) Undecided, Ambivalent, Not Applicable, or No Opinion

4) Agree or Positive

5) Strongly Agree or Strongly Positive

In addition, there was space for subjective comments. Sample averages for various questions are presented below.

8.1 Short Course Evaluation

Table 2 in the appendix summarizes the results of the scaled questions for the 19 responses to the evaluation of the short course.

The short course evaluation subjective questions established the strengths and weaknesses.

Major strengths listed included:

1) Hands-on experience. (10 people said most important)

2) Flexibility. (3 people said most important)

3) Learning atmosphere. (2 people said most important)

4) How much learned. (2 people said most important)

5) Existence of a course (in conservative Wyoming).

6) Course convinced me to use computers in classroom.

7) Financial support made it possible for me to attend.

Major weaknesses listed included:

1) Need more than one minicomputer. (9 people stressed this)

2) Need more structure. (4 people stressed this)

3) One week is to short. (3 people stressed this)

4) Need hard copy unit for mini. (2 people stressed this)

5) Need more examples of in class use. (2 people stressed this)

6) Need better student teacher ratio.

7) Need to cover file maintenance techniques.

8) Should do more with audiovisual aids.

9) Weather was bad.

10) Nothing at all.

8.2 Final Evaluation

Table 3 in the appendix summarizes the results of the scaled questions for the 11 responses of participants who received two weeks of home-site computer usage and the 15 total responses.

The final evaluation was designed to determine not only whether the project met its goals (it did), but also how valuable the participants felt the project would be for others to have (very much so). There was also a subjective section in the final evaluation to elicit suggestions for improvement of future projects. These comments generally were similar to the weaknesses pointed out in the short course evaluations. They included:

1) Lengthening the short course.

2) More computers for short course.

3) Better library of materials traveling with machine.

4) Separate participants into ability classes.

5) Have an advanced session.

6) Make it available for every teacher.

7) Increase site visit time.

Finally, a survey was taken of almost 300 science and mathematics teachers regarding the program. Over 20% responded. Eighty percent of the respondents felt that they would benefit from such a program and well over 80% indicated a desire to apply for such a program if offered.

9. Conclusion

The conclusions to be drawn from this report are obvious. Not only was the project extremely successful, but also it was well received and highly recommended. The project staff has gained valuable insight into running a similar project in the future. With appropriate support, computer technology can be introduced into most, if not all, high schools in the nation.

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	Question	Mean	Standard Deviation
1.	The physical facilities in which the course was held were conducive to the learning environment.	4.16	.74
2.	The materials displayed and worked with in the course were effective.	4.26	.44
3.	There was good rapport among the students in the course.	4.74	.44
4.	The sessions provided opportunities for expressing and sharing ideas.	4.68	.46
5.	Students spent class time involved in worthwhile activity.	4.11	.79
6.	Help and encouragement were readily available from the instructional staff.	4.84	.36
7.	Formal presentations by instructional staff were stimulating.	4.16	.81
8.	The objectives of the course were clear.	4.05	.69
9.	The objectives of the course were realistic	4.05	.76
10.	The topics and activities were appropriate to the course objectives.	4.21	.83
11.	The information provided by the course is usable.	4.58	.49
12.	The overall design of the course facilitated student involvement.	4.47	.50
13.	Students were encouraged to explore new ideas.	4.63	.48
14.	The course stimulated student interest.	4.53	.50
15.	The course has helped me to understand computers more clearly.	4.32	.86
16.	The instructional methods employed in the course have helped me to understand new instructional concepts.	3.63	.87
17.	The course has increased my awareness of the available instructional alternatives.	4.16	.87
18.	The course has helped me toward the achievement of the objectives I have as a teacher.	4.16	.59
19.	The course satisfactorily met my expectations.	4.00	1.03
20.	I approve of the grading policy employed in this course.	4.32	.73
21.	I would recommend this course to my fellow students should the same instructional program be offered again.	4.63	.58
22.	I would attend another course conducted by the group who planned this course (if they topic interested me).	4.63	.58
23.	The course was effective rather than ineffective.	3.95	.60
24.	The course was pleasant rather than unpleasant.	4.74	.44
25.	The course was valuable rather than worthless.	4.47	.60
26.	The course was interesting rather than boring.	4.42	.59
27.	The course was important rather than unimportant.	4.58	.59
28.	The course was student centered rather than teacher centered.	4.63	.58

Table 2. Evaluation of Short Course

Question	Homesite Mean	Homesite Standard Deviation	All Responses Mean	All Responses Standard Deviation
1. Did the project help you to be better able to develop student appreciation of computer role in society?	4.55	.50	4.40	.61
2. Did the project help you to be better able to remove the mystery and bewilderment that may exist in the student's mind about computers and automation?	4.45	.66	4.40	.61
3. Did the project help you to be better able to enrich existing programs through use of the computer? Allow students to work on creative and complex problems that would be impossible to solve by manual methods?	4.73	.45	4.60	.61
4. Did the project help you to be better able to motivate students and teachers to more individual, challenging instruction?	4.27	.62	4.33	.60
5. Did the project help you to be better able to develop the student's abstract reasoning ability and general problem solving skills? Teach him algorithmic thinking and explore rigorous thought processes?	3.91	.67	3.93	.68
6. Did the project help you to be better able to encourage students to apply computer concepts creatively to a variety of application areas?	4.64	.48	4.40	.61
7. Did the project help you to be better able to prepare college-bound students with an understanding of the computer and how it can and cannot be used to solve problems?	4.55	.78	4.47	.81
8. Did the project provide you with a strong background in computer programming techniques--with emphasis in the BASIC language--so that you would be equipped to teach computer programming in your school?	4.27	.45	4.27	.44
9. Did the project introduce you to recent developments in the usage of computer technology in educational systems?	4.64	.64	4.47	.72
10. Did the project provide a computer facility to allow exploration of computer technology in the individual setting of your own school?	4.91	.29	4.40	1.14
11. Did the project train you to act as resource person to aid in administrative decisions with regard to computer technology in the local school system?	4.27	.62	4.20	.65
12. What is the overall value of the project as it applied to you?	4.55	.50	4.40	.61
13. How important do you feel it is for other teachers in the state to have a project such as this available to them?	4.91	.29	4.73	.57
14. Relative importance of the following on a 1 to 4 scale:				
intensive short course	1.91	1.00	1.67	.94
resource function of University	3.91	.29	3.47	.81
staff site visit	2.64	.48	2.80	.54
homesite computer usage	1.45	.50	2.00	1.10

Table 3. Responses to Evaluation