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ABSTRACT

This quantitative/qualitative evaluation of an 80-hour course integrating the SCOPE Computer Program in Mathematics and Science into the curriculum for students, grades 6-12, was conducted to: (1) provide immediate feedback to facilitate improvement of the program; (2) determine course effects; and (3) provide practitioners with an effective method of evaluating microcomputer use in educational settings. Careful evaluations of programs involving computer instruction and education are needed for progress in computer literacy and computer integration into the core curriculum. Data were collected from the 370 participating students, 13 instructors, eight lab assistants, and four program coordinators using pretests, interim feedback forms, posttests, and 40 hours of evaluator observation data. National Assessment of Educational Progress items were part of the test battery. Results showed gains in computer programming skills, mathematical problem-solving, and attitude toward computers. Sex differences were found in cognitive gain, use of computer labs, and discipline. Teacher training was part of the program. The appendix contains the "Formative Evaluation Feedback-SCOPE Session I," designed to assist personnel continuing to conduct the program. Findings and recommendations concerning student behavior, physical facilities, field trips, parent day/parent communication, the curriculum, and instructional strategies are presented. In addition, some unsystematic observations and conclusions are offered. (BS)

Evaluating a Computer Education Program Qualitatively and Quantitatively

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Abstract

Despite the tremendous popularity of computers in education, there have been few examples of evaluations of computer education programs. A qualitative/quantitative evaluation of an 80-hour program that integrated computers with mathematics and science was conducted which involved 370 secondary level students. Gains were shown in computer programming skills, mathematical problem-solving, and attitude toward computers. Sex differences were found in cognitive gain, use of computer labs, and discipline. National Assessment items were used as part of the test battery. The study provides a method for conducting comprehensive evaluations of educational programs involving computers.

Introduction

As an independent part of a multifaceted program which provided computer education to persons from preschool age to adults, the SCOPE Computer Program in Mathematics and Science was presented to 370 students in grades 6-12, spread throughout 14 class sections. Instructors from the University of Georgia, the University of Kansas, Florida International University, the University of Illinois, and the University of Hawai'i developed and taught the curriculum, which emphasized the integration of microcomputers into classrooms featuring problem-solving in mathematics and science.

Objectives

The major purposes of this study were a) to provide immediate feedback to facilitate improvement of the SCOPE Computer Program and b) to determine the effects of the 80-hour course that integrated the use of the microcomputers into a curriculum with substantial mathematics and science content. Because of the relative lack of useful, relevant writings in the professional literature, another objective emerged: to provide practitioners with an example of an effective method of evaluating the use of computers in educational settings.

Perspectives/Theoretical Framework (integrated with) Methods and Techniques

Evaluation methodology has undergone substantial development since Cronbach's (1963) and Scriven's (1967) now classical works. Shortly after the appearance of those articles, Steele (1973) located over 50 different evaluation models. Worthern and Sanders (1973) suggested that the wisest approach was for evaluators to use an eclectic model developed individually for each specific situation. By 1978 Webster and Stufflebeam found it necessary to develop a 13-category typology of models of evaluation. Then in 1980 Cronbach and Associates produced a comprehensive review, which severely criticized much of the previous work in the field of evaluation. A year later a prestigious joint committee headed by Stufflebeam published the _Standards for evaluations of educational programs, projects, and materials._

In order to select strategies most appropriate for an evaluation of the effectiveness of a program involving computers and mathematics and science, it was crucial that certain evaluation mistakes from the past not be repeated. The evaluation must not neglect a careful description of the phenomenon (Charters & Jones, 1973). It was not until recently, however, that enthnographic/naturalistic methods have become sufficiently developed by researchers such as Rist (1975), Ward and Tikunoff (1978), and Moos (1979) for use in large-scale evaluation studies.

Another evaluation mistake to be avoided was attempting to carry out a stand-alone, summative, go/no-go study in which a program is decreed as either "successful" or "unsuccessful" (Cronbach, 1980). Rather the evaluation was designed so as to contribute to the enlightenment of discussions concerning the important strengths and weaknesses of the program (Parlett & Hamilton, 1977; Cronbach, 1980)

In order to be meaningful evaluation must go beyond the assessment of whether goals have been attained. While a completely goal-free approach such as suggested by Scriven (1972) was seen as too extreme, nonetheless, the evaluation emphasized side effects (positive or negative, anticipated or unanticipated) and emphasized a rich data collection not limited to the professed goals of the project.

Many early evaluations were strongly influenced by experimental design and accordingly required that the treatment not change as the study was carried out. Such a rigid approach promoted internal validity at the expense of external validity (viz., generalizability). Cronbach (1982) regards internal validity as of only secondary concern to the evaluator. Contracts written to express that inflexibility were more concerned with fiscal/legal matters than with obtaining worthwhile evaluation information. The attempt to impose models for the evaluaton of Title I programs met substantial criticism (Linn, 1980). A more fruitful approach was used which allowed for appropriate adjustment throughout the life of the evaluation combined with the development and systematic use of historical data. The importance of looking at long-term as well as more immediate effects has been well documented by Scriven (1974) and Kaufman and Thomas (1980).

One of the main lessons learned during the past several years is that evaluations are likely to be unused unless specific provisions are built in to ensure their use. Besides identifying relevant audiences and means of dissemination, the evaluation design included a policy implications component which addressed how the evaluation findings might be used.

Systematic expert judgment can be a valuable contributor to program evaluation (Anderson & Ball, 1978). Bryk (1978) has gone even further in arguing that the integrative capacity of the clinical mind is far superior to our computer technology which permits incredibly complex multivariant analyses of data. Likewise Eisner (1975) advocated the use of a connoisseurship model as the best means of evaluating and appreciating the extremely complex phenomenon called education.

Evaluations that tend to be more flexible, more naturalistic, and more adaptable reflect what Stake (1975) refers to as "responsive evaluations." The general organizer of the responsive model is audience concerns and issues. Such a model promotes use of evaluation by virtue of its design; furthermore, it can accommodate any other organizer as seen needed. Guba and Lincoln (1981) have argued that responsive evaluation that includes naturalistic solutions to methodological problems is the most generally useful of the evaluation models that have emerged so far. It is somewhat ironic that an evaluation involving computers with their aura of objectivity can benefit substantially from using qualitative/naturalistic methods.

In summary a review of the educational evaluation literature combined with field experiences involving the evaluations of many programs have led to certain conclusions regarding which strategies were the most appropriate for the evaluation of the SCOPE computer education program. Such an evaluation (a) was responsive, (b) emphasized naturalistic description, (c) focused on how the services might be improved, (d) went beyond the study of whether project goals were attained, (e) regarded systematic expert judgment as valuable, (f) built in a usability and policy implication component, and (g) looked at long-term as well as short-term effects.

Data Source

A total of 370 students split between two four-week sessions constituted the main data source. Evaluation data were also collected from 13 instructors, 8 lab assistants, and 4 program coordinators. Pre- and posttests included 21 attitude items, 10 cognitive items, and 6 items from the National Assessment of Educational Progress. An additional 11 evaluation feedback items were added to the posttest. A 10-item interim feedback form was also used after the first week of each session.

Finally the evaluator spent 40 hours in classroom and laboratory observation. Methods developed by the Far West Laboratory for Educational Research and Development were used to collect observational data such as academic learning time and instructional features.

Data were analyzed using SAS supplemented with content analyses. By collecting much of the data on optical scan sheets it was possible to provide feedback to project staff within a few days of the data collection. A formative evaluation report that was submitted to the project staff is included in the appendix.

Results/Conclusions

Student engagement time was close to 100% in the computer labs but slightly lower in the lectures. Gains were shown on the basic knowledge test in mathematics problem-solving, in computer programming, and on the attitude scale. Boys had on the average higher pretest cognitive scores, but girls caught up on the posttest. Boys were more frequently discipline problems; they also used the computer labs during free time more that did the girls.

On a number of occasions, mathematical concepts that would have been difficult to handle without a computer were taught (e.g., construction of polygons where angles and sides were systematically varied, lengthy searches for prime and relatively prime numbers, and geometric construction requiring composite functions and recursion).

Students gave the program high ratings in terms of organization, pace, opportunities for asking questions, amount of work required, opportunities for meeting other students, and comprehensibility. The major complaint was not enough time on the computer. Students gave the program the following overall grades: A(39%), B(44%), C(13%), D(4%).

Problems related to discipline, facilities, field trips, and rescheduling were discerned and addressed during the program. As a part of the approach used, eight teachers received inservice training such that they are now fully qualified to teach the SCOPE program. An additional 60 teachers were given a four-week introduction to computers in education.

Educational Importance of the Study

Although there is an abundance of computer education programs, there are few that attempt to integrate computers into the core curriculum. Furthermore, there are few examples of evaluations of programs involving computers. It is almost as if the tremendous popularity of the computer has overshadowed the need to carefully evaluate the effectiveness of the many programs involving computer instruction and education.

When evaluating such programs, it is important to apply the best methods available. Both qualitative and quantitative methods are appropriate. Use of the computer itself to assist in the evaluation is still in the exploratory stage.

Some of the variables which proved to be useful to collect for the evaluation were student attitude, student background differences, student expectations, active engagement time, level of knowledge of computer skills versus subject area, degree of equipment sharing, physical environment (i.e., ambient temperature, acoustics, space, smell), interactive skills, peer learning, teamwork in problem-solving, legibility of monitors, availability of computer outside of the classroom, outdatedness, attendance, male/female ratios, time constraints, real benefit of actually having the computer for instruction, coordination of lecture with lab, overall grade, individual dominance, level of creativity in learning, teacher backgroud/knowledge, and availability of resources (software, instructional aides).

In summary this study has educational importance because (a) it helped improve the curriculum development and teaching involving computers, mathematics, and science--all topics for which needs have recently been strongly expressed, (b) it determined the effectiveness of an 80-hour intensive program integrating computers and problem-solving in mathematics and science, and (c) it provided examples of methods for evaluating computer education programs. Only by continuing to carefully evaluate such programs can there be efficient progress toward developing computer literacy and integrating computers into the core curriculum.

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Appendix

SCOPE

FORMATIVE EVALUATION FEEDBACK - SCOPE SESSION I

This report is designed to provide immediate feedback to persons involved in the operation of the SCOPE project (secondary level). It is based on data collected during the first session of SCOPE which was held June 13 - July 8, 1983 at the College of Education of the University of Hawai'i.

Organization of the report

Because the purpose of this report is to assist personnel who are in the process of continuing to conduct the SCOPE program (session II), it is organized along the lines of topics/concerns rather than evaluation design. Data were collected through several means: pre and posttests of attitude and knowledge, evaluation feedback from students after the first week of class as well as at the end of the program, classroom and lab observations, discussions with program personnel, discussions with students, and analyses of materials.

FINDINGS

1. Student behavior

Students came to the program with differing degrees of maturity and of computer experience. In each of the eight sections there was a range of at least six points on a ten-point test of basic knowledge. The students also differed in their attitudes toward computers; for example, in response to the statement "It is important to know about computers in order to get a good job" 10% strongly agreed, 41% agreed, 28% were undecided, and 21% disagreed. On an item taken from the National Assessment of Education Progress, students on the pretest gave the following reactions to how much help a computer would be in writing a novel: 17% said "Computer helps a lot," 54% said "helps a little," and 28% said "Computer does not help."

Given these wide ranges in student characteristics, one might expect corresponding difficulties in the classroom. An inspection of the pretest scores of some of the "problem students" showed that they tended to be at the extremes — relatively high as well as relatively low. A concern was expressed that students who were advanced in computer use should not necessarily be placed in the upper sections because the mathematics may be too advanced; however, in a case where such a switch was made, the younger student had no trouble keeping up with the class.

It was also learned that several students were in attendance because their parent(s) wanted them to be there. In addition several students had not expected an emphasis on mathematics and science. They had expected or at least hoped for a fun-and-games focus.

Students' lack of seriousness manifested itself in several ways such as passing notes, reading material not from the course, sleeping, not taking notes or not even having paper and pencil (on one occasion I observed one pencil being shared by three boys), apparently living for break time, being (very) tardy, not completing assignments, and violating set rules such as no computer games in lab and no food in class.

On a more positive note most of the students did make a serious effort to learn during the lectures as well as in the lab. With rare exceptions, all of the students in the lab were actively engaged in working on the computer. Student engagement time in the lecture sections varied quite a bit. Those students observed to be not engaged for a substantial amount of time included high as well as low pretest (knowledge) scorers.

RECOMMENDATIONS: In the future make it clear that students who are not serious about behaving in class and learning about mathematics and science through computer applications are not wanted; furthermore, if problems occur, such students will be asked to leave the program. As to the wide range of background, again it should be made clear as to the goals of the program; for example, if we are focusing on the beginning student, then advanced students either have to apply to a special section (not yet existing) or have to understand that they must adjust to the curriculum, not vice versa. In some cases moving students to a higher age level group seemed to work; however, the mathematics may prove to be a problem for the student who is advanced with regard to computers, but not with regard to mathematics or science (a great question from one of the younger students as the teacher was discussing Mendel's laws: "..but how do you cross(breed) plants?").

Other methods observed for improving behavior: reduction of lab time ("more lab time" was the most frequent suggestion from students on how the course might be improved), no credit, separation of symbiotic trouble makers, and reduced break time.

2. Physical facilities.

A modern remodeling miracle took place just before the start of SCOPE -- two computer labs appeared where none had been before. Not only were the physical facilities able to handle the complex scheduling involving hourly room switching, but they also faithfully served evening and weekend classes. The labs usually comfortably accommodated 30 students, two lab assistants, up to three instructors, and even an occasional evaluator.

The labs were rather cool at times. Because of the necessity to share machines, students sometimes operated in cramped positions and sometimes did not sit such that they could operate the keyboard efficiently. There might have been some benefit, pedagogical and otherwise, from sharing the computers. Question: Are we providing a computer for every two students because of financial limitations, or do we regard the set-up as desirable? Some hypothesized benefits from sharing computers in the lab are development of interactive skills, learning from peers, learning to solve problems as a team, and providing real-life examples that problems can be solved in more than one way.

The College Center (Wist Hall) has become famous for its poor acoustics. But did you know (or do you care?) that unless the windows are strategically opened, it is also frequently stuffy and hot? But if you open all those windows, then the traffic on University Avenue together with the mating mynah birds and the raking gardeners exacerbate the poor acoustics. Of course the air conditioning for the nearby lab just makes noise for the lecture room. Monitors are not legible for the 80-column Pascal (the switch to 40-columnshelped somewhat). Even for BASIC programs, sometimes it was very difficult to read from the back of the room. All of these problems are possibly moot as the move has been made to room 111 in Wist. Now about that room 111...apparently a great improvement...but, sometimes no room for eager evaluator or properly checked-in guest. Overhead "screen" could be smoothed out. Left monitor (from students viewpoint) can be glary. Difficult to walk amongst the students. (note: it has just been reported that even the room 111 problems have been taken care of!).

Moving on to "Annette's Room." This regular University Lab School classroom was seen as substantially better than the Wist Hall College Center. There were some problems with monitor glare (left one from students' viewpoint), street and nearby classroom (below and right next door) noise (including typing), ventilation, and the need to use the back chalkboard. (On one occasion I observed six out of thirty students not bothering to turn around to look at the back chalkboard as it was being used.). At least the chairs do not squeak so much. (Students need to be warned not to abuse the furniture -- such as sitting on the plastic desk tops which break easily. On the other hand the plastic chairs do not squeak.)

The field trip room used to be the one that "smells like kitty litter -- used kitty litter." (SCOPE student, 6/83). That room should not be used by breathing humans. We also interfered with the normal operations of the office next door when we tied up their phone line for the telecommunications demonstration. Now that the College Center is available,...

No one had much time to have any meetings, but having offices spread out didn't help much -- Mainland folks in Wist Annex (C&I), Sid(?), Burt, & Peter in the portables, some in UHS-2, some in UHS-3; however, it would have been virtually impossible to have everyone located in a central area. Where was the best place to send mail? To this day, I am not sure. Now, if we all had an electronic mail system set up. Actually a real need was expressed for having a computer available outside of the lab. Many of the master teachers were having to teach things that they themselves had not had a chance to try out first.

RECOMMENDATIONS: Continue to monitor rooms and make improvements as needed. Ideally there would be enough room for teachers to walk around to monitor students' work, enough chairs for students, evaluator, and observing instructors and visitors, no monitor glare, ideal temperature, good acoustics (still a bit echoey in 111), good screen for overheads, and possibly the setup of a non-dusty means of writing such as dry-erase boards or simply the large easel type pads -- not gaudy, but no down time due to power outages, burned out bulbs, or lack of transparencies). Same requirements for other rooms, including for field trips (but see section on field trips).

Provide at least one Apple IIe computer (outside of the labs) for the instructors. Preferably more than one. If they have to come from the labs, that may be a reasonable trade-off.

3. Field Trips

Extensive evaluation information on the field trips has been organized by John Southworth. The current feeling is that the excellent and the poor ones have been identified. It still seems to me, however, that the field trips were born of necessity to free the labs moreso than to enlighten the students about real life applications of computers. The amount of energy required to conduct the field trips is tremendous.

RECOMMENDATIONS: Consider dropping all field trips. If you need to free up the labs, then have a movie showing on campus or other similar nearby demonstrations.

As to our "promise" to provide such enlightenment with regard to applications in the real world, I would recommend that we stop making such promises and instead concentrate on teaching the curriculum that has been developed for the lecture and labs. Can't solve all of the world's educational problems

4. Parent Day/Parent Communication

Good attendance and a worthwhile event; however, several students were fidgety because the session was adult focused. Some of the students in attendance were actually younger siblings of SCOPE students. It was good for the parents to get to at least see the other teachers and staff. It was inconvenient for Dean Andrew In who had to give a speech four times on the hour. In order to show parents the academic quality of the program, the assignment sheets should be made available. As it was, I saw (as a parent) a few computer programs, which ran, but were rather mysterious as to their purpose. Students after the first week of class would probably not be very effective in writing user-friendly programs (e.g., after typing 'RUN' for one of the programs, the screen simply showed a '?').

The parents were told that SCOPE was an experimental program. I'm not sure if that is a proper description of the program. Answering parents' questions was useful. The curriculum descriptions were also very important and interesting.

Having student introducers was a nice touch, but they were sometimes inaudible. In the session I attended the boys introduced the men, and the girls introduced the women. Given that leis were presented, shouldn't it be the other way around for at least some of the introductions?

Parents may or may not be informed about what happens in SCOPE depending on how much their child shares with them. Should we provide some sort of report card -- more along the lines of curriculum than student achievement? The curriculum is impressive and worthwhile sharing with parents, perhaps even ahead of time so they can make more informed decisions about enrolling their child in the program.

RECOMMENDATIONS: Include some curricular handouts on Parents' Day. Arrange it so that Andy In does not have to spend an entire morning mainly giving about 10 minutes worth of welcoming remarks. Have students prepare (specifically) to demonstrate their programs to their parents. Select as introducers only those students with projecting voices (or simply do not have student introducers).

Consider having two sessions only whereby a given class of students will take their parents to the lab while the other group hears details on the curriculum. They then switch (SCOPE staff by now is the world's foremost expert on lecture-lab movement). Parents would be willing to hear in the large group session about the program in general, even if some aspects do not apply specifically to their child.

5. Curriculum

For a program such as SCOPE there did not exist a ready-made curriculum. The morning instructors separately as well as cooperatively developed the needed curricular materials and instructional strategies. It was fortunate that Media Services was able to deliver the materials generally on time with very short lead time.

At times it was very difficult for the master teachers to prepare their lessons because of lack of time to observe, digest, integrate, and then customize to their own teaching style. Should be somewhat easier for the second session; however, master teachers have expressed the need to learn more about the topics covered by other than the teacher they had been observing during Session I.

Students sometimes seemed in need of reference manuals (but obviously a heavy cost item). There are inexpensive reference cards for the Apple II+; however, I haven't seen any for the Apple IIe. Being able to rely on the lab assistants for guidance had its positive as well as negative aspects -- many students felt free to not pay attention in the lecture session because they knew they would get help as needed in the lab. On the other hand, students did not have to spend inordinate amounts of time poring through manuals in an attempt to get things to run properly. But in this way, perhaps we are denying students a real-life experience -- the frustration of trying to trouble shoot with a manual. But then again, SCOPE is only an 80-hour program.

Because of the mathematics/science focus of the program, it seemed important to investigate whether the content really needed computers for instruction. On a number of occasions it was clear that the computer was essential to the teaching of the concepts that were being presented; for example, generalizations of the shape of figures (decagon, pentagon, 10-pt star) where sides and angles were varied systematically over a wide range of values. Lengthy searches for prime and relatively prime numbers were quickly conducted with the aid of the computer. Geometric figures which required input in terms of composite functions could not have been dealt with as nicely had there not been a computer to assist. The teaching of probability concepts benefited greatly from having the speed and power of the computer to carry out Monte Carlo simulations. The list goes on and on.

Other mathematical topics covered included number theory, recursion, story problems, trigonometry, randomization, factorization, modulo, series, sequences, and logic. Scicnce topics included Mendel's laws, ecosystems, population, a d velocity.

RECOMMENDATIONS: Continue to develop and revise the materials. During the second session, the master teachers will have the opportunity to customize the curriculum to their own teaching philosophies and styles. Continue to formatively evaluate the curriculum in terms of effectiveness on student learning as well as appropriateness for teachers. Eventually plan for formal teacher training for teachers not familiar with the materials.

6. Instructional strategies

By observing several times in each of the eight classes I was fortunate to be able to see several different strategies being used in somewhat similar situations. Many of the instructors have not had enough time to learn what techniques have been used in the other classes. The following list of observed strategies is of necessity selective. Additional comments are based on my observations which are obviously limited in depth.

a. have a problem-solving contest. To make the competition fairer, students were given a common starting point program.

b. students told that it is okay (and even 'good') to make mistakes. Programming without mistakes is unrealistic.

c. examples given where the use of a computer is neither required nor desired.

d. have students individually work out a problem during the lecture section. This strategy was used because students were not really involved in learning from the lecture (see earlier comment regarding students' being able to get as much help as they wanted from the lab assistants).

e. tell students to "push their programs,"; that is, try strange and extreme values. This lesson also addressed debugging by manually trying out values and following them through the steps of the computer program.

f. repeat students' answers and questions, especially in the Wist College Center. Otherwise impossible for others to hear what the student said.

g. pass out problem sheets as the students file out of the lecture room on the way to lab. Save class lecture time (if that's what you want to save).

h. call on students by name to get responses. Questions addressed to the class in general often do not get responses from local students even though they know the answer.

i. remind students to take notes. Apparently in many schools, note-taking is not standard behavior.

j. compare different computer programming languages applied to the same problem. I was surprised to hear moans and groans when it was announced that they would go back to LOGO (after spending some time on BASIC).

k. lecture coordinated with lab handouts.

l. have screens turned off in lab so teacher can get their attention.

m. have students produce data (orally) before attempting to solve a problem on the computer.

n. lab assistants asked to ask as well as answer questions.

o. have students restate the problems they are working on. A related concern is making sure the students understand the mathematics before they try to "solve the problem by computer."

p. show color graphics at times. Students literally gasped when a color graphic appeared on the screen.

q. use of a problem whose solution is nonintuitive (e.g., the birthday problem). Ironically in at least two of our larger classes, there were no matches.

r. provide more advanced students with additional problems and/or ask them to adapt given programs for higher level applications.

s. ensure that students understand the task before they attempt to try solutions.

t. have students provide written estimates of solutions to problems. These are then collected before the computerized solution is presented.

Some non-random, unsystematic observations:

Boy-girl comparisons. There were twice as many boys as girls in the program (in one class the ratio of boys to girls was about 9:1). Boys had on the average higher pretest (knowledge) scores, but the girls caught up on the posttest. Boys utilized the labs before class in a higher proportion than "expected" (Ratios on two occasions in the Wist Lab were 17:3 and 9:1). Boys were also disproportionately represented among the students not engaged during the classroom lecture. Some girls, however, managed to make the "trouble makers" list.

Local students. Non-responses have already been discussed. In some cases students use of pidgin English may have resulted in their not being "heard." For example, when one student saw that hiding the turtle in LOGO resulted in the figure being created more quickly, he said "How come go mo fast?" He also happened to be in the last row, and I was probably the only person who heard and understood what he said. At other times it was difficult for me to understand what students were saying. Usually the teachers managed to grasp the essence of the students' words.

Mathematics. Given the different schools from which the students came, it is not reasonable to expect much commonality in mathematics background; for example, trigonometry and radians were briefly touched upon. For many students it was the first they ever heard such ideas. Likewise, concepts like relatively prime, greatest common multiple, recursion, and negative integers varied tremendously in familiarity to students. The Mathematics Department at the University of Hawai'i requires the passing of a placement test and/or a grade of at least C in a prerequisite course. Eventually SCOPE may want to do some sort of placement testing.

Evaluation. Right now rather weak on measuring the depth of the learning of the students in the various age-level sections. Observation schedule based more on availability than on a systematic approach. Did not use microcomputers to collect any of the data. Not specifically budgeted as part of the program.

Teachers. Very impressive. Students who were there to learn were fortunate to have such an opportunity. Likewise those who took the teacher course have indicated the high quality of the experience. Despite the frantic schedule, especially for the master teachers, a substantial amount of learning took place among the local staff, whose computer education knowledge is now a major asset of the college.

Student Gains. Mean gains on the 10-item cognitive test that contained basic items in the computer literacy arena were generally slightly less than two points (overall t = 14.2, df = 184, p .0001). Pre-post changes on an attitude toward computers scale showed a slight positive gain of an average of about .2 per item on a 5-point scale (t = 6.1, df = 184, p .0001). Other (perhaps better) evidence of student gain included assignments given and collected, work done and stored on diskettes, and ability to respond to questions in class.

Student feedback. Students gave the program high ratings in terms of organization, pace, opportunities for asking questions, amount of work required, opportunities for meeting other students, and comprehensibility. In addition to the previously mentioned desire for more computer lab time, student suggestions included having the field trips focus more on computers, separate class by ability, shorter/fewer lectures, more specific instructions, longer days/programs, and allow time to play games. Several students said they really liked using the computers, learning different programs, the quality teaching, the field trips, learning problem solving, the individualized attention, and educational games.

Of the 185 students who gave an overall grade to the program, 71 (39%) gave A's, 82 (44%) gave B's, 24 (13%) gave C's and 7 (4%) gave D's.

Conclusions

The major problems related to student discipline, physical facilities, field trips, and frantic scheduling have been addressed and appear to be under control in Session II. Four of the master teachers are currently integrating their experiences from Session I into their own customized lesson plans for Session II.

Student gains were shown in (a) basic computer knowledge, (b) computer programming skills in two languages, (c) mathematical problem solving skills, and (d) attitude toward computers. Master teachers also increased their knowledge of programming and in addition, learned several pedagogical applications.

As a result of the SCOPE program (Session I), about 200 secondary students are now notably more capable of using the computer, especially in the area of mathematical problem solving. Eight local master teachers are capable of continuing to teach students with the types of curricular materials and approaches used in SCOPE. Several computer lab assistants have had valuable experience in aiding beginning as well as more advanced students. The SCOPE organization staff has likewise gained valuable experience in carrying out a complex program such as SCOPE was. The five mainland expert teachers have had the opportunity to develop and refine their curricula on the basis of applications with a population somewhat different from what is typically available on the mainland. The evaluation staff has also had the chance to develop and refine techniques that will be useful for future evaluations of computer education programs. Finally one of the most visible legacies of SCOPE is the computer hardware that is now available for training, research, and other worthwhile, enjoyable human endeavors.