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Georgia State University - College of Education PH.D. 1983

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A STUDY ON GROUP INSTRUCTION VS. DIRECTED STUDY TECHNIQUES FOR TEACHING COMPUTER PROGRAMMING TO GIFTED SECONDARY MATHEMATICS STUDENTS

by

MARTHA HENDRICKS KASILUS

A DISSERTATION

Presented in Partial Fulfillment of Requirements for the Degree of Doctor of Philosophy in Educational Leadership in the Department of Curriculum and Instruction in the College of Education
Georgia State University

Atlanta, Georgia

1983

ACCEPTANCE

This dissertation, A STUDY ON GROUP INSTRUCTION VS. DIRECTED STUDY TECHNIQUES FOR TEACHING COMPUTER PROGRAMMING TO GIFTED SECONDARY MATHEMATICS STUDENTS, by MARTHA HENDRICKS KASILUS, was prepared under the direction of the candidate's dissertation committee. It has been approved and accepted in partial fulfillment of the requirements for the degree Doctor of Philosophy in the College of Education, Georgia State University.

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ABSTRACT

A STUDY ON GROUP INSTRUCTION VS. DIRECTED STUDY TECHNIQUES FOR TEACHING COMPUTER PROGRAMMING TO GIFTED SECONDARY MATHEMATICS STUDENTS

by

MARTHA HENDRICKS KASILUS

Purpose

This study sought to design, implement, and evaluate two computer courses for gifted secondary school students; to predict student achievement; and to determine if there are differences with regard to sex in ability to learn computer programming and attitudes toward computer science.

Procedure

The 93 subjects for this study were participants in the Governor's Honors Program in 1979. Two teaching strategies, a direct group instruction approach (T_1) and a directed independent study approach (T_2), that incorporated the same course content comprised the two treatments.

This study used a multigroup pretest-posttest design. The instruments used were: View of Mathematics Inventory (VMI), Barron Independence of Judgment Scale (BIJ), Internal-External Locus of Control (LOC), Test of Computer Programming

Ability (TCA), Test of Prerequisite Knowledge (TPK), Student Information Profile (SIP), and Number of Computer Programs Completed (NPC). Analysis of covariance, *t* tests, correlations, multiple regressions, and discriminant analysis were used to assess 12 hypotheses.

Results

Both treatment groups scored significantly higher on the post-TCA ($p < .0005$) than on the pre-TCA. Neither teaching method significantly changed the subjects' attitudes toward computer science, independence of judgment, or locus of control.

It was not possible to predict the scores on the post-TCA based on the view of computer science, locus of control, or independence of judgment. NPC could be predicted by post-BIJ, post-VMI, and post-LOC for T_1. For T_2 none of the tests predicted the number of programs run.

A subject's sex did not affect his or her ability to program a computer or attitudes toward computer science.

Conclusions

The design of a computer course in which the computer is used to study mathematical concepts was accomplished. Sex was not a factor in either the subjects' abilities to write and run computer programs or attitudes toward computer science. For gifted secondary school students, both the direct group instruction and the directed independent study approaches appear to be effective means of teaching computer programming.

List of Abbreviations

BIJ	Barron Independence of Judgment Scale
GHP	Governor's Honors Program
LOC	Internal-External Locus of Control
NPC	Number of Programs Completed
SIP	Student Information Profile
T_1	Treatment 1, the directed independent study teaching method
T_2	Treatment 2, the direct group instruction teaching method
TPK	Test of Prerequisite Knowledge
VMI	View of Mathematics Inventory

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Chapter 1

INTRODUCTION AND PROBLEM STATEMENT

The purpose of this study was to design, implement, and evaluate a course in computer programming for gifted secondary students using two different methods of instruction. One group of students studied computer programming with direct group instruction each class meeting. Another group of students studied programming through directed study in which students were encouraged to work on their own with little or no direct group instruction. Secondly, the study was designed to investigate a method for predicting those students who succeed and respond better to each of these methods of instruction. Thirdly, the study was designed to examine the differences in achievement of the students according to sex and prior use of programmable calculators. Tests were administered to measure ability to program a computer and to determine attitudes toward computers. A record of the time spent using the computer was kept. Also as an important part of the study, tests were given to help predict the better of the two teaching techniques for the individual student.

The subjects in the study were mathematically gifted secondary school students who participated in the Governor's Honors Program (GHP) during the summer of 1979. This first chapter presents the background and rationale for the study, the assumptions and the constraints of the study, and concludes with the definitions of pertinent terms and the statement of the problem.

Rationale

The rationale for curriculum development in computer programming with and without group instruction for the gifted student is considered next. In the report "Science and Engineering Education for the 80s and Beyond," the National Science Foundation (1980) suggested that we are fast becoming a nation of technological illiterates. The report recommended that computer literacy be incorporated in the school curriculum. Although there are many definitions of computer literacy, many educators agree with Luehrmann (1982) that a major component of computer literacy is computer programming. Hart (1981) noted that in addition to incorporating computer literacy courses in the curriculum, many schools have increasingly turned toward the idea of integrating computer science and mathematics.

The necessity for research in the area of instructional computing is viewed by many educators as one of the most pressing tasks facing educational computing. There are a number of unsettled issues related to how and when computer programming should be introduced in the school curriculum.

In his article "Going for the Gifted Gold," Rice (1980) described a program for the gifted in Westchester County, New

York, where he lived and in which his son was involved. He described his son's computer course as being stimulating enough to keep him up late at night voluntarily reading books on computer language and writing programs to try out in class.

Rice (1980) further related that when he drove his son and four of his schoolmates to their computer class, he was struck by their excitement. They ran to the computer center where their instructor, Ron Gindick, turned them loose at the computers. When the student programmers got stuck, Gindick suggested, "Why don't you discuss it together and see if you can come up with the solution?" (p. 58) The noise that the students made didn't bother Gindick. He described it as the sound of excitement: "They're discovering that learning can be fun" (p. 58). They were finding out more than just how to program. "I'm using the computers only as a vehicle for teaching the kids lots of other things," said Gindick: "How to explore new materials, how to discover new things on their own, how to share and help each other learn" (p. 58).

In Mathematics Framework for California Public Schools, the California State Board of Education (1975) stated, "Learning is a group experience in that group behavior affects the learning process, as pupils do learn from one another" (p. 3). The opportunity for student interaction which the nonlecture method provides is certainly a valuable means of learning for, as the California Board of Education related, "Mathematics becomes a vibrant, vital subject when points of view are argued, and for this reason interaction among pupils should be encouraged" (p. 3). The Board also explained that the classroom climate should be under the direction of the teacher, but it should be pupil-oriented and self-directed. The teacher should assume the role of a guide who directs learners to explore, investigate, and estimate.

As early as 1975 the California Board of Education stated that all students should develop computer literacy:

> The mathematics program in grades nine through twelve should provide for the acquisition by students of knowledge about the nature of a computer and the roles computers play in our society; and for some students, the opportunity to acquire skills and concepts in computer science. (p. 36)

The California Board also expressed a need for programs for talented students: "The mathematics program in grades nine through twelve should provide for the development of programs for talented students" (p. 36). Introduction to computer programming was among the suggested topics for the talented mathematics students.

Fey (1980) discussed the most effective uses of different media for mathematics instruction with computers being one of the best. Fey stated that "although a variety of influential uses of computers have been found in education, the predominant and most natural instructional application has been in mathematics" (p. 409). The most common use of computers in the mathematics classroom is to aid in problem solving. Fey further related that studies in the Minnesota Computer-Assisted Mathematics Project (CAMP) identified material in the existing school mathematics program that could be effectively studied through the design of computer programs. Hatfield and Kieren (1972) compared learning programs in which students programmed problem-solving procedures on several concepts with instructional methods involving no programming. Although student achievement did not seem to increase with the use of the computer, programming was helpful in learning complex tasks that required the organization of data or infinite processes.

Fey (1980) also discussed the relative merits of different patterns of organizing instruction. Recently educators have often followed the model of business in applying a systems approach to curricular and instruction design, and these educators have most often been inspired by a desire to offer individualized programs. Most programs of individualized instruction in mathematics share the following broad characteristics:

> Content goals expressed as student performance objectives and organized into scope-and-sequence strands or hierarchies. Instructional material packages to guide independent student learning of individual objectives or group of related objectives. Criterion-referenced tests to assess student mastery of objectives and to guide the prescription of appropriate learning activities. Substantial freedom for students to choose their own pace, if not content sequence, of learning. Teacher role defined primarily by managerial tasks--record keeping, testing, prescribing student learning activities, and tutoring individual students or small groups with similar problems. (Fey, 1980, p. 411)

In programs of individualized instruction, students are expected to assume a major responsibility for learning while teachers do very little expository instruction and more managerial and tutorial work.

> The major innovative features of individualized instruction have been subjected to intense critical scrutiny in the journals and the meetings of mathematics teachers; there have also been at least 100 recent research investigations comparing the effects of individualized instruction and more conventional approaches to instruction. (Fey, 1980, p. 412).

Furthermore, Miller (1976), after reviewing the research on individualized instruction, concluded that tested programs appeared to yield slightly higher achievement and slightly better attitudes than conventional programs.

One measure of the success of a course in computer programming or any mathematics course is the attitude toward mathematics that it fosters in students; hence, a measure of attitude is important. Kulm (1980) gave two definitions of attitude:

> An attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related. Attitude is an organization of several beliefs focused on a specific object or situation predisposing one to respond in some preferential manner. (p. 356)

Kulm continued by pointing out the kinds of attitudes that might be measured: mathematics content, mathematics characteristics, teaching practices, classroom activities, and mathematics teachers. Kulm outlined several ways of measuring these attitudes: self-report, observation of behavior in a natural setting, reaction to partially structured stimuli, performance on objective tasks, and physiological reactions. In this study all five kinds of attitudes were measured using self-report scales, observation of behavior, and performance.

But why bother with attitudes toward mathematics? According to Kulm (1980), recently the need for a traditional college education has been questioned and the alternatives, such as vocational or trade schools, have not established the same mathematics prerequisites that colleges have in the past. Also automated banking, tax-preparation services, shoppers' guides, and other services designed to minimize the necessity for computational work, along with the availability of inexpensive calculators, will continue to argue against the necessity for training in many mathematics areas for the majority of students (Kulm, 1980).

In another definition of attitude as stated by Kulm (1980), attitude is viewed as approximately the same thing as enjoyment, interest and, to some extent, level of anxiety.

In "Individual Differences and the Learning of Mathematics," Fennema and Behr (1980) discussed studies showing that anxiety and mathematics are related. In general, high anxiety is associated with lower achievement in mathematics. The National Longitudinal Study of Mathematical Abilities (NLSMA) indicated that decreases in facilitating anxiety appeared in grades four through ten, with females' scores decreasing more than males' scores. Debilitating anxiety increased for females during the same period.

> The literature strongly suggests that there are sex-related differences in the confidence/anxiety dimension (Fennema & Sherman, 1978). It appears reasonable to believe that less confidence or greater anxiety on the part of females is an important variable that helps explain the difference in

> the number of males and females entering mathematics-related fields of study and employment. . . . Girls underestimate their own ability to solve problems. (Fennema & Behr, 1980, p. 334)

In an article in the March, 1980, issue of The Mathematics Teacher, Fennema stated that "females are receiving inadequate mathematical education in high schools" (p. 169). She blamed this in part on teachers who pay more attention to males than to females. Not only do males receive more discipline or blame from teachers, they also receive more praise. This is true of both male and female mathematics teachers.

In "Regardless of Sex," Burton (1979) said that "young women underrate their ability in mathematics" (p. 262) and that "gifted women are discouraged from studying mathematics" (p. 264). In a scenario, Fennema (1980) related the following:

> John is a gifted student who is excelling in mathematics. His teacher has encouraged him to join the mathematics club and arranged for him to take an advanced mathematics class at the college level. Mary, also a gifted student, finds math very easy, and she likes it. Her teacher feels she should try to become more outgoing and involved with the other girls and social events at the school. The teacher urges Mary to join the debate team and a women's social club. (p. 172)

Burton (1979) stated that "teaching the subject in a meaningful way and insuring that all prerequisite knowledge is a part of the student's repertoire is extremely helpful in promoting positive attitudes toward mathematics" (p. 268). Both Burton and Fennema implied that teacher attitude and encouragement can help change female students' math anxiety into positive attitudes toward mathematics. The teacher can make a difference.

The attitude that one cannot succeed in a certain area is related to a person's view of internal versus external control of reinforcement. Learning will be different under these two conditions. There may be significant and important individual differences in the degree to which people see their own lives as determined by their own behavior and characteristics or see their lives as controlled by luck, chance, or fate. According to Rotter and Hochreich (1975), people may differ along the dimension of a generalized expectancy for internal versus external control of reinforcement.

Therefore, attitude, sex differences, and internal versus external locus of control may be important considerations in designing a course in computer programming.

Assumptions

The assumptions upon which the study is based are presented below.

1. The mathematics students at the Governor's Honors Program, summer of 1979, in Macon, Georgia, are representative of the population of students referred to as highly gifted.

2. Independence of judgment can be assessed using the Barron's Test of Independence of Judgment (BIJ).

3. Attitudes toward computer science can be assessed using the View of Mathematics Inventory (VMI) revised to read "computer science" instead of "mathematics."

4. The test of prerequisite knowledge can be used to assess student knowledge of prerequisites.

5. The test of computer programming ability can be used to assess ability in computer programming.

6. Computer programming can be used as an important tool in the learning of mathematics, especially with regard to problem solving.

7. Secondary gifted students should learn computer programming to enable them to function better in a computer-oriented society.

Any generalizations of the results of this study to a larger population will be a function of the degree to which the subjects correspond to those in this study and the assumptions hold. The following sections provide a discussion of the constraints, definitions, and problem statement.

Constraints

The constraints of the study follow.

1. The subjects were all students of high mathematical ability who had been chosen for the Governor's Honors Program during the summer of 1979. They were all gifted mathematics students and, therefore, they represented only a subset of the general population.

2. The environment at the Governor's Honors Program was different from the traditional classroom setting with more freedom offered and independent study encouraged. Hence, a number of variables could not be controlled by the investigator.

3. There was no access to student IQ scores.

4. Time was limited; there were only eight class meetings of just over an hour each.

Definitions

For the purpose of this study the following terms are defined.

1. Attitude. For this study an attitude is a mental position with regard to computer science as measured by the View of Mathematics Inventory (VMI) revised to read "computer science" instead of "mathematics."

2. Computer literacy. Currently what constitutes computer literacy is a widely debated issue, but for the purpose of this study computer literacy is defined to be an understanding of computer capabilities, computer applications, and computer algorithms.

3. Directed independent study. In the directed independent study teaching approach, little direct group instruction is given. Each student is given a list of computer programs to be written and run with the instructor acting as a consultant.

4. Direct group instruction. In the direct group instruction teaching technique, direct group instruction is given daily on both the mathematical concepts involved and the actual writing of the computer programs.

5. External locus of control. The belief that positive or negative reinforcement following some action of the

individual is not contingent upon his own action but is the result of chance, fate, or luck is defined to be external locus of control.

6. Gifted. The gifted person is one whose cognitive potentials, when developed, can meet or exceed the minimum cognitive capacities needed to function as a high-level innovator, evaluator, or problem solver in a society.

7. Governor's Honors Program. The Governor's Honors Program (GHP) is a program for high-achieving gifted secondary school students from all over the State of Georgia. The students who participate in the program go through a careful screening process involving evaluation of teacher recommendations, transcripts, standardized test scores, and personal interview.

8. Hardware. The pieces of computer equipment are referred to as hardware. The five major components of a computer are an input device, a storage unit, a central processing unit, a control unit, and an output device.

9. Internal locus of control. An individual's perception of an event as contingent upon his own behavior is considered to be internal locus of control.

10. Program. A computer program is a planned sequence of instructions written in a special language or code that tells the computer system what steps to perform in order to produce a desired result.

11. Software. Software refers to the programs and routines or procedures that are in storage in the computer.

Statement of the Problem

The purpose of this study is to answer the questions posed below.

1. Can one design, implement, and evaluate two courses in computer programming, one with direct group instruction and one without direct group instruction, for gifted high school students?

2. Is it possible to predict which students will achieve more using group instruction and which will achieve more working independently as measured by the Test of Computer Ability (TCA) and the Number of Programs Completed (NPC)?

3. Are there differences with regard to sex in ability to learn computer programming and attitudes toward computer science as measured by the TCA, the NPC, and the View of Mathematics Inventory (VMI) revised to read "computer science" instead of "mathematics"?

Summary

In this chapter the rationale, assumptions, constraints, definition of terms, and statement of the problem for the study were presented. The next chapter contains a review of the literature on computers and giftedness.

Chapter 2

RELATED LITERATURE REVIEW

This chapter presents a discussion and review of literature related to this study.

With the advent of the microprocessor technology, more and more computers are being used by even small businesses and in homes. The computer is no longer the machine of the rich and big business only, but it is an educational tool in many homes.

This inexpensive, small, and simple product has provided a self-contained computer that can be used in any classroom, library, home, or office. It has become increasingly clear that microcomputers will be the vehicle to bring computer awareness and computer based or assisted instruction into the schools.

Furthermore, there has been renewed emphasis on developing one of our most important national resources, the gifted or talented child. The contributions of the gifted to society are invaluable.

Since it is not possible to review all of the vast literature on computing and giftedness, only selected topics are reviewed.

Instructional Computing

As early as 1973 in "Selecting Goals for an Introductory Computer Programming Course," Moursund related that the instructional use of the computer in the secondary schools was growing rapidly. Instructional uses of computers can be divided into two categories, those that require student knowledge of computer programming and those that do not. The second category includes computer-managed instruction, various forms of computer-assisted instruction, such as drill, tutorial, gaming and simulation, and the use of canned programs to do the computations involved in solving particular problems. Computer programming is a fundamental tool in general problem solving. The computer is an essential tool to many people who attempt to apply mathematics to "real life" problems. "Thus it is natural that computing should come into the mathematics classroom, and that mathematics teachers should get involved in the teaching of computer programming" (Moursund, 1973, p. 599).

There are two major differences between teaching mathematics and teaching computing. The first difference is in the preparation of the teacher. The secondary mathematics teacher has an educational background that includes a minimum of a bachelor's degree in mathematics, which means that the teacher has at least four years of formal study above his teaching level.

> The field of mathematics is well established, highly structured, and supported by a large variety of high-quality modern textbooks. Although the

> curriculum is subject to considerable change, the overall course content at the secondary level is fairly stable. (Moursund, 1973, p. 599)

The typical secondary school teacher who is teaching computer programming has less than one year of formal study in the field of computer science. Thus, the teacher does not have the deep insight and experience, as in mathematics, gained by years of formal study at a higher level than the course he is to teach. The second major difference lies with the computer science itself, for it is a young, rapidly expanding field. Changes in computer hardware and software are now taking place rapidly; new and better textbooks are being published continually. "The total amount of research being done in the field is increasing rapidly, and the effect of this research is felt at the most elementary levels" (Moursund, 1973, p. 599). Computer science is a very large, deep field that is changing so rapidly that it has not stabilized at the most elementary levels.

Even the programming languages are changing. During the first decade of computer design, each computer system had its own language. In the late 1950s the FORTRAN (FORmula TRANslator) language was designed for scientific use, and the COBOL (COmmon Business-Oriented Language) language was designed for business use. In the middle 1960s the BASIC (Beginners' All-purpose Symbolic Instruction Code) language was created expressly for students. BASIC became the primary computer language for time-sharing systems and for mini- and micro-computers. Pascal, named for the famous mathematician, gained widespread popularity (Golden, 1981).

Computer science is a rapidly evolving field. Specific skills learned today will rapidly become obsolete. It is the principles which underlie these skills that will continue to be relevant. Even a student who aspires only to be a programmer needs more than just programming skills. The equation Computer Science = Programming is not enough. Students need to understand issues of design, of the capabilities and potentials of software, hardware, and theory, and of algorithms and information organization in general (Ralston & Shaw, 1980).

In a panel discussion at the Annual Conference of the Association for Computing Machinery (Dalphin, 1979), the answers to two questions were sought: (1) What is computer science?

> Computer Science is an application-oriented activity centered around the computer itself. Systems and programs, design methodology and practice, applications and operation of computers, and theory are all part of Computer Science. (Dalphin, 1979, p. 5)

and (2) What is computer science education?

> Answering the question may require looking beyond Curriculum 68 or 78 into those curricula which have a strong "Computer Science" component yet have a strong applications orientation. (Dalphin, 1979, p. 5)

Many things affect the selection of goals for an introductory computer programming course. A major one is the available hardware. Historically, programming was taught either on a batch-processing system (using cards for input) or on a time-shared system (using a typewriter terminal for input and output). Many schools are now using self-contained microcomputers. In most secondary schools using batch-processing the hardware was limited with only a few key punches. The computer used to run the programs was not generally located in the school and, therefore, the programs could be run only once a day. Schools using time-shared computing facilities usually had only one or two terminals, making student access to the computer a real problem. Even in schools with microcomputers, the number of computers does not usually satisfy student demand.

Software was also a factor in the setting of goals. The most widely used batch-processing language was FORTRAN, and the most widely used time-shared language was BASIC. Some batch-processing systems gave access to a form of FORTRAN that was not student oriented. Not all time-shared systems provided the BASIC language, and the various manufacturer's versions of BASIC varied considerably. One of the monumental problems in creating a computer programming course for high schools was obtaining access to a good system which would accept the language needed and to find a good textbook and other materials for the course. The goals of an introductory programming course should be consistent with available hardware and software (Moursund, 1973).

David Moursund (1973) proposed the following goals for a high school computer programming course:

> Goal 1: To give the teacher training and experience in organizing and teaching an introductory programming course at a particular academic level and under particular restrictions on hardware and software.
>
> Goal 2: To add to a student's problem-solving skills.
>
> Goal 3: To familiarize the student with some of the types of problems a computer can solve (that is, some of the capabilities and limitations of computers).
>
> Goal 4: To teach computer programming.
>
> Goal 4a: To provide the student with the programming skills he needs for personal use.
>
> Goal 4b: To prepare the student to go on to a higher-level computer science course.
>
> Goal 4c: To prepare the student to get a job in the computing field. (pp. 600-602)

Moursund's goals make good secondary goals, but the primary goal of a computer programming course in a mathematics classroom should be to use the computer as a tool in the teaching of mathematics. The authors of the Computer Assisted Mathematics Program (CAMP) believed strongly that the computer should not dominate or dictate the mathematics curriculum (Kieren, 1969). Rather, the computer should serve as an instructional aid in the attaining of the existing goals and objectives upon which a modern mathematics program is built. They tried to select topics that are normally stressed in the secondary mathematics courses. It was not their intent to teach computer science. Students using the CAMP books were not expected to acquire an understanding of the electrical or mechanical operation of a computer, and they were not attempting to train students to become programmers in the vocational-educational sense.

> In short, the books in the CAMP series use the computer as a problem-solving tool. Nearly all the lessons focus on teaching the students to design and test algorithms (programs) for the kinds of problems they are likely to encounter in their regular textbooks. (Katzman, 1970, p. vi)

CAMP Algebra utilized the computer in the teaching of the following mathematical concepts: absolute value, distance, repeating decimals, solving equations, slope, finding equations of lines, graphing equations, solving 2x2 systems of equations, factoring, and solving quadratic equations. CAMP Geometry covered the following topics: area of polygons, the Pythagorean theorem, Pythagorean triples, proportions, geometric and arithmetic means, right triangles, trigonometry, vectors, the law of sines, the law of cosines, coordinate systems, distance, conic sections, and the circle. CAMP Intermediate Mathematics contained a good review of many concepts covered in algebra and geometry. Some topics covered were: linear and quadratic functions, complex numbers, matrices, trigonometry, sequences, series, and limits. CAMP Second Course covered the following: square roots, factors, equivalent fractions, properties of rational numbers, fractions, decimals, percents, pi, maximum, minimum, the Pythagorean theorem, equations and inequalities in one variable, and formulas. Throughout the CAMP series the emphasis was on the use of the computer as a tool in the teaching of mathematics.

Another textbook which was widely used in the teaching of computer science in the high school was Computer Science: A First Course (Forsythe, 1969). In this book the author's purpose was to help the student understand the world where information of all kinds is a prime commodity. Forsythe related that computers are an indispensable tool in information processing, and students in this course would learn not only what computers are but what computers can and cannot do--they would learn to understand and appreciate the step-by-step methodical chain that begins with a problem, processes it through a computer, and ends with a satisfactory solution. The author further believed that this book would prepare the student for a college-level course. But the book centered around the study of computing rather than the computer. Many computer textbooks place significant emphasis on the design of computer networks of circuits and electronics that make up a computer, but this computer course dealt with the organization of problems so that computers could work them. Computing hinges primarily on the study of algorithms, not only learning to understand them but learning to construct and improve them (Forsythe, 1969). The textbook was written using flowcharts with language supplements so that hopefully the book could be used with whatever software was available in the particular school.

Although this book was not as mathematics-oriented as the CAMP series, it was based on the teaching of computer science using mathematical concepts, such as the Euclidean

Algorithm, approximation of square roots and the sine function, roots of equations, locating maxima and minima, computing areas, convex functions, the midpoint rule, simultaneous linear equations, averages, and mathematics of prediction.

The book was divided into three parts. Part I was a basic introductory unit which covered the algorithm, flowcharts, conceptual model of a computer, computation, and data organization. Part II was primarily concerned with numerical applications and covered procedures, functions, and mathematical application. Part III was devoted to non-numerical applications of computing or symbol manipulation.

The authors of Calculus--A Computer Oriented Presentation (Cricisam), a textbook which used the computer as a tool for the teaching of calculus, used a chapter from Computer Science: A First Course as an introduction to computer programming (Stenberg, 1968). The remainder of the book provided a presentation of the calculus using the computer. The course was rigorous, and theoretical material was somewhat de-emphasized. But many concepts in calculus lend themselves quite well to the use of the computer, such as computing area under the curve using upper and lower Reimann sums, the midpoint rule, and the trapezoidal rule and finding limits.

According to the Teacher's Commentary--Elements of Calculus and Analytic Geometry (Duncan, 1967):

> The problem about the proofs of limit theorems is to bring together the more formal knowledge of epsilons and neighborhoods and the intuitive realization of what is actually happening. Time and time again teachers have had students return to the school from college reporting that only after the third exposure did the proof of a limit theorem really sink in. Do not expect complete understanding at once. Rather, encourage the student to build better knowledge and realization, with the understanding that in all probability neither will be complete! (p. 22)

Truly, the concept of limit is one of the most difficult theories that the high school student encounters. But the computer can be beneficial in doing the calculations necessary to see that the limit of a sequence is a particular number. A simple BASIC program can be written to generate a sequence such as $\{(3n-1)/(2n+4)\}$ for n = 1 to 100:

```
10  FOR N=1 TO 100
20  PRINT N, (3*N-1)/(2*N+4)
30  NEXT N
40  END
```

The output from this program shows the student that as _n_ gets larger and larger the terms of the sequence get closer and closer to 1.5.

The CAMP series of textbooks was a pioneer in the field of computer-assisted mathematics. Along with the CAMP series, _Computer Science: A First Course_ and _Calculus--A Computer Oriented Presentation_ were widely used textbooks at the time the present study was conceived. Many other good texts are used today in the computer science field. One such book is _Computer Programming in the BASIC Language_

(Golden, 1981). "What the author of this book has done in this second edition is take a very good BASIC programming text and make it even better" (Norris, 1982). The original version of the book was written primarily for high school time-sharing users, but the second edition is updated to be compatible with microcomputers. The first five chapters contain most of the essential elements of BASIC, chapter six covers matrices, and chapter seven discusses additional BASIC features (Golden, 1981).

Programs can be used in the teaching of individual mathematical concepts in the mathematics classroom. Programs can be written to produce Pascal's Triangle (Curley, 1974), which is a rich motivational tool in teaching many mathematical concepts. Pascal's Triangle can be related to the number of subsets of a set, combinations, and expanding a binomial. The sum of the diagonals form the Fibonacci sequence (Graflund, 1970). According to David Duncan (1975), "Pascal's Triangle has been a rich source of patterns in mathematics." He related a recently found pattern involving prime numbers: "Let p be a prime and let Pascal's triangle be written mod p. If n=1, row p^n of this form of Pascal's triangle has the property that its internal entries are all zero" (p. 23).

Computers can also be used in the study of cones (Damaskos, 1969), numerical and monte carlo methods (Flynn, 1974), place value (Norris, 1974), polynomials (Bidwell, 1975), polar graphs (Wagner, 1982), polar coordinates

(Allison, 1977), approximating pi (Walther, 1969), quadratic equations (Zabinski & Fine, 1979), limits (Johnsonbaugh, 1976), generating theorems (Battista, 1982), helping prove theorems (Hay, 1981), geometric transformations (Shilgalis, 1982), graphing polynomials (Dugdale, 1982; Kennedy, 1981), and graph interpretation (Phillips, 1982).

Computers can also be used to study probability and statistics. Programs can be written to compute the mean, median, variance, standard deviation, and the standard scores for a group of data. "Using computer programs written in BASIC and the graphics facilities of microcomputers, students can be made aware of assumptions of statistical models" (Edmond, 1982).

Surely the computer is having a marked impact on education in mathematics in the college as well as in the high school. As early as 1972 in Recommendations on Undergraduate Mathematics Courses Involving Computing, four ways in which the computer can influence undergraduate mathematics education were suggested:

> 1. Computing can be introduced into traditional mathematics courses.
>
> 2. New courses in computationally-oriented mathematics topics can be designed.
>
> 3. The entire curriculum can be modified to integrate computing more fully into the student's program.
>
> 4. Computers and computer-related devices can be used as direct aids to mathematics instruction. (Committee on the Undergraduate Program in Mathematics, 1972, p. 3)

Part of the high school teacher's responsibility is to prepare the student for his college courses in computing.

But the computer has vast application outside the realm of the mathematics classroom. Computer programs can be very valuable in setting up the calculations needed in chemistry, physics, and other science courses. For example, Newton's second law of motion, $F=ma$ or since $a=v^2/r$, $F=mv^2/r$, can be found rapidly by using a very simple computer program (Williams, 1972).

Computer music, computer dance, computer painting, computer-animated movies, computer-generated pictures, and computer pictures are all interesting topics for the art department of a high school to pursue. For example, computer-produced movies are playing an increasing role in education and research.

> The microfilm recorder consists essentially of a display tube and a camera, and it can plot points and draw lines a million times faster than a human draughtsman. This machine and the electronic computer which controls it thus make feasible some kinds of movies which heretofore would have been prohibitively intricate, time-consuming, and expensive to draw and film. (Reichardt, 1969, p. 67)

In "Pascal's Triangle and Computer Art," Lund (1979) displayed several programs and the designs they generate. The drawings started by Lund's wanting to provide a nice example of a program featuring a need for two-dimensional arrays and grew into some intricate computer art.

With the advent of the microcomputer many school systems can now offer computer programming to their students.

In the June 30, 1980, edition of Newsweek in an article titled "And Man Created the Chip," Sheils proclaimed the advances in machines that think. Sheils stated that "a new generation of electronic servants has been spawned--and they will change the way we all live" (p. 50). We have advanced from computers that fill entire buildings to microprocessors, entire computers on a chip. The February 20, 1978, issue of Time magazine contained a special section devoted to "The Computer Society," which explained how the world of electronic sorcery works and examined its impact on our daily lives.

Computers are having such a vast impact on many aspects of society that many educators believe that they must offer computer courses. There is much talk of computer literacy. The Committee on Computer Education of the Conference Board of the Mathematical Sciences (1972) defined computer literacy as an understanding of computer capabilities, computer applications, and computer algorithms. Anderson, Klassen, and Johnson (1981) believed that computer literacy must encompass the following domains: programming and algorithms, skills in computer usage, hardware and software principles, major uses and application principles, limitations of computers, personal and social impacts, and relevant values and attitudes. The National Council of Teachers of Mathematics Board of Directors approved the statement that an essential outcome of contemporary education is computer literacy. "Every student should have first-hand experiences with both the capabilities and limitations of computers through contemporary applications" (Johnson, Anderson, Hansen, & Klassen, 1980, p. 91).

More schools are using computers today than ever before. In "A School Computer Network," McGaig and Jansson (1978) stated that "The number of schools using computer processing has doubled in the last three years" (p. 694).

Braun (1981) provided the following guidelines to schools purchasing computer equipment:

a. Get the most parts that your budget permits.

b. Do not choose a particular computer unless there is a body of users of that computer in your region.

c. Buy from a local dealer.

d. By peripherals with care. (pp. 593-594)

Braun (1981) further advised the educator that the three best microcomputers for classroom applications are the Apple, the PET, and the TRS-80. Folk (1978) stated that "microcomputers will have a dramatic impact on the availability of computing power throughout our society, including the educational system" (p. 612).

In a position statement the Board of Directors of the National Council of Teachers of Mathematics (1978) stated that "Educational decision makers, including classroom teachers, should seek to make computers readily available as an integral part of the education program" (p. 468). No matter which system is used--batch system, time-sharing system, or microcomputers--computers are becoming an important part of the educational process.

Although the computer has a place in many aspects of the high school curriculum, its primary purpose in this study is to be utilized in the teaching of mathematics. Finally, students should understand the relationships between computers and mathematics. Mathematics is an important tool and will continue to be in the future. Computers are an important aid to using that tool and will become a greater aid in the future.

There is very little disagreement about the importance of computers in education; however, Luehrmann (1982) noted that there are a number of unsettled issues related to instructional computing. One of the major issues concerns how and when programming should be introduced in the curriculum. For a number of years, most educators assumed that a knowledge of algebra was necessary for the study of programming; some educators (Hart, 1981; Milner, 1982; Papert, 1980, 1981) have now suggested that programming should be introduced much earlier in the curriculum.

As more and more computers become available in classrooms, many of the issues in educational computing will be the subject of further research.

Giftedness

There have been many attempts at defining giftedness, listing the characteristics of the gifted, and identifying the gifted. Likewise, many approaches to curricula for the gifted and methods of teaching the gifted have been proposed. Due to the vast amount of literature on giftedness, only a few of each of these considerations above about the gifted are discussed.

History

"Few thinking individuals would not concur that undeveloped potential of the United States' gifted and talented youth is one of the greatest national resources and one which creates untold social cost if unrealized," remarked Dorothy Sisk (1978, p. 354). In Mathematical Talent, Stanley, Keating, and Fox (1974) referred to the highly able as the most disadvantaged group in the schools because they are almost always grossly retarded in subject matter placement. In a discussion of Stanley et al.'s statement, House, Gulliver, and Knoblauch (1977) stated:

> the subject matter retardation can have serious effects on students' mathematical performance not only because of failure to develop their talent but also through the influence on students' attitudes and aspirations toward mathematics. (p. 223)

House et al. (1977) also stated that there seems to be a highly disproportionate emphasis on and funding for the needs of slow learners. Teachers at all levels should maximize the growth of every student in both cognitive and affective domains. "Hence, all students must be allowed full opportunity to be educated to the limits of their ability. The gifted student has not been given this opportunity" (House et al., 1977, p. 222).

The Russians' launching of Sputnik resulted in the National Defense Education Act (NDEA) of 1958. "The focus of the N.D.E.A. program was on mathematics and science and was intended to locate and develop the best young minds in these areas" (Sisk, 1978, p. 354). The national panic caused by Sputnik caused an increase in curriculum development and advancement in mathematics and science especially for the gifted students. The Committee on Mathematics at the National Education Association Conference on the Academically Talented in 1958 stated several trends in mathematics education. Some of these are contained in the following:

> 1. Renewed emphasis on more mathematics for superior students. . . .
>
> 3. Topics and even entire courses are being moved from the college level to the high school level.
>
> 4. General mathematics is being extended into two or even three years in high school. Larger schools are developing three-track programs. . . .
>
> 10. Increased emphasis on visualization, concrete representation, laboratory experiences, field work, projects, etc. . . .
>
> 13. Renewed emphasis on the program of individual differences. Homogeneous grouping is being advocated. Enrichment, acceleration, special classes are advocated for the gifted.
>
> 14. Increased appreciations of the role of attitudes, interests, and appreciations in learning. (Gowan & Demos, 1964, pp. 232-233)

The Committee also stated that schools should experiment with programs for the mathematically talented and that the conventional mathematics curriculum of the high school should include units on such concepts as probability and statistics, number systems, symbolic logic, nature of proof, topology, non-Euclidean geometry, and use of computers (Gowan & Demos, 1964).

Unfortunately, the majority of the programs developed as a result of the National Defense Act did not have a lasting effect on education provisions for gifted, and educational programs developed for gifted and talented were sporadic and not widespread (Sisk, 1978). Although in 1967 President Lyndon Johnson requested that a White House Task Force be established in the area of gifted education, the report of the Task Force was not made public until the opening of the Johnson Library in 1974 (Sisk, 1978).

"However, in 1969 the Amendments to the Elementary and Secondary Education Act known as Public Law 91-230 included provisions related to gifted and talented youth" (Sisk, 1978, p. 355). This amendment, which passed by a unanimous vote in both the Senate and the House, provided three sources of support funds for the gifted. Further evidence that the locus is shifting back to interest in the gifted is the creation of an interagency team within the Office of Education which is to develop a plan for maximizing educational opportunities for gifted and talented students (Sisk, 1978). Also, 14 states now mandate special education for gifted children in all public schools so that the gifted are being considered on the state level as well as the federal level (Rice, 1980).

Definition

The first consideration when developing programs for the gifted is defining giftedness. The United States Office of Education (USOE) has defined gifted and talented children as persons who, by virtue of outstanding abilities, are capable of high performance.

> USOE specifically includes those with demonstrated achievement or potential in any of the following areas, singly or in combination: general intellectual ability, specific academic aptitude, creative or productive thinking, leadership, visual and performing arts, or psychomotor skills. (House et al., 1977, p. 222)

Lucito (1977) defined the gifted person as anyone whose cognitive potentials, when developed, can meet or exceed the minimum cognitive capacities needed to function as a high-level innovator, evaluator, or problem solver in a society.

The Georgia Department of Education (1976) defined gifted students as students who are intellectually gifted if their potential cognitive powers, when developed, qualify them to become high-level innovators, evaluators, problem solvers, leaders, or perpetuators in the complex society in which they live.

According to Katena (1977), a gifted child is one who excels in one or more of the following:

1. general intellectual ability (measured by IQ scores);

2. specific academic aptitude (for example, good in mathematics can be measured by an aptitude test used to predict);

3. creative or productive thinking (can be measured by Torrance's Test of Creative Ability in which he measures Gilford's areas of intellect which for creativity include fluency, flexibility, frequency, and originality);

4. leadership ability (usually measured by teachers or peers);

5. visual or performing arts (dance, music, art, etc.); and

6. psychomotor ability (football, gymnastics, etc.).

Perhaps those people who can perform well but cannot conceptualize are talented, but not gifted.

There are many definitions of gifted, perhaps because the gifted population is so diverse. Some elements included in most definitions are problem-solving abilities, academic achievement, high IQ scores, creativity, success leadership ability, cognitive potential, activities that are valuable to society, and talent. Today the term gifted refers not only to intelligence, but also to these other traits.

Kirk (1972) defined giftedness as a superior ability to deal with relationships, thoughts, and knowledge. He believed that this ability may be due to intelligence or creativity, or both. Durr (1964) believed that creativity is the distinguishing characteristic of gifted individuals.

A gifted person is one who is able to analyze, synthesize, and evaluate information. The investigator's definition of a gifted person is one who is capable of high-level thought--convergent, divergent, abstract, and logical.

Identification

Using the definition decided upon for giftedness, the next concern is identifying the gifted. George, Cohn, and Stanley (1979) stated that a school should define the gifted before it begins the task of discovering students with these characteristics. They believed that verbal ability is frequently overemphasized in identifying the superior student, for scientific, artistic, and social talents are needed in the world today. George et al. (1979) commented that "the discovery of the gifted is not easy" (p. 79). According to George et al., the following criteria could be considered in identifying the gifted: teacher judgment, scholastic record, and standardized tests. George et al. stated that screening procedures of teacher nomination and group testing, although commonly used, often fail to identify large numbers of gifted children.

Schools select gifted children in a wide variety of ways. In some schools, gifted means being in the top 2% to 5% or more of the population. Very often, the number is determined by the amount of funds available (Rice, 1980).

> Many programs combine I.Q. and achievement-test scores with teacher recommendations, extra curricula accomplishments, parent and peer recommendations. But for initial screening, most depend on I.Q. scores. The minimum score for eligibility as gifted ranges from 120 in Miss. to 135 in California. (Rice, 1980, p. 57)

Perhaps IQ is used extensively because administrators like the security of using an "objective" score.

But intelligence and achievement tests fail to identify many gifted children, largely because tests measure knowledge rather than the process of thinking. Also, numerous studies show that, while scores accurately predict school performance, they bear little relationship to accomplishment in the real world (Rice, 1980).

Perhaps tests and recommendations should be used to separate the school population into three groups: those who are definitely gifted, those who are not gifted, and those about whom we are not sure. Then the uncertain group should be tested further, observed, or put into the gifted program on a trial basis. For the uncertain group, a student should not be identified on the basis of one score or one procedure. Different identification methods, measurements and observation by people who know should be combined to find gifted (Lucito, 1977). Perhaps 1-1/3 standard deviations above the mean could be tried.

What is best for the given school or program to identify the gifted is what works there (Lucito, 1977). "Many researchers are finding that a combination of approaches appears to be the most effective method of identifying gifted and talented students" (Tuttle, 1980, p. 57).

Characteristics

Characteristics of the gifted should also be considered before developing curricula for the gifted. Many lists of characteristics of the gifted have been generated. Typical of such lists of characteristics reflecting gifted are the following:

A gifted individual--

1. is curious.

2. is persistent in pursuit of interests and questions.

3. is perceptive of the environment.

4. is critical of self and others.

5. has a highly developed sense of humor, often a verbal orientation.

6. is sensitive to injustices on personal and worldwide levels.

7. is a leader in various areas.

8. is not willing to accept superficial statements, responses or evaluations.

9. understands general principles easily.

10. often responds to the environment through media and means other than print and writing.

11. sees relationships among seemingly diverse ideas.

12. generates many ideas for a specific stimulus. (Tuttle, 1980, p. 13)

Gowan and Torrance (1971) indicated the following as guideline descriptions of students who are creatively gifted:

1. Reacts positively to new, strange, or mysterious elements in his environment.

2. Persists in examining and exploring stimuli to know more about them.

3. Is curious, investigative, asks penetrating questions.

4. Has original approach to problem solving and unusual solutions.

5. Is independent, individualistic, self-sufficient.

6. Is imaginative, fantasy creating, a story teller.

7. Sees relationships.

8. Is full of ideas, verbal; has conversational fluency.

9. Prefers complex ideas, irritated or bored by routine.

10. Can occupy time usefully without being stimulated by the teacher. (p. 150)

One important characteristic of gifted students is their independence. Barbe (1975) discussed a comparison of a group of 42 superior and 42 average adolescents matched on social class, age, religion, sex, and nationality background. Students scoring over the 95th percentile on intelligence tests were in the superior group, and students scoring between the 25th and 75th percentiles made up the average group. The most significant difference between the groups was in independence, with the gifted being significantly higher in independence.

Lucito (1965) compared the behavior of intellectually bright and dull children in an experimentally designed independence-conformity situation. Three hypotheses were tested and the results were:

1. The bright children as a group were significantly less conforming to their peers than the dull children in the total independence-conformity situation.

2. The bright children as a group were significantly less conforming to their peers than the dull children on both difficult (ambiguous) and easy (nonambiguous) tasks.

> 3. The similarity between the extent of conformity exhibited by the dull group on the two levels of task difficulty (ambiguous and non-ambiguous) was significantly greater than that exhibited by the bright group. (p. 74)

Another characteristic in mathematical precocity is in sex differences. Fox (1976) stated that "it is generally agreed that sex differences exist in average mathematical aptitude and achievement among adolescent and adult populations" (p. 183). She based this statement in part on the differences in SAT scores between the sexes with boys generally scoring higher. Astin (1974) reviewed literature in which one of the findings regarding sex differences was that although girls tend to be superior on verbal abilities, boys do better on spatial and mathematic aptitudes. Fennema (1980) believed that the literature suggests there are sex-related differences in confidence and anxiety dimensions which may cause some of the sex differences in performance.

An alarming characteristic was reported by Anastasi (1974), who found that as scores on three screening tests in mathematics and science increased liking for school decreased. Attitudes of the gifted toward school and school curriculum is an important part of the characteristic of the gifted for consideration by the educator.

Barbe (1975) suggested a reason for attitude problems of the gifted: "The gifted child is often shortchanged in a system that sees the learner as the passive receiver of knowledge" (p. 443). In Teaching the Gifted Child, teaching by the discovery method is advocated as a method of training gifted children to adopt a set of attitudes about knowledge itself. Torrance and Reynolds (1978) emphasized differentiated programs for gifted and talented students. They believed that "Images of the future of gifted and talented students are immensely different from those of their less gifted and talented peers--so different that different methods, materials, and procedures are required" (p. 40).

One method used with gifted students is individualized instruction, because many teachers must deal with all levels of ability within a single classroom. Cline (1979) suggested self-directed learning for the gifted. A teacher should go from "command style" to "guided discovery" learning.

McDonald (1975) explained some of the pros and cons of individualized instruction. Some of the advantages cited were that, first, each student progresses at his own rate; hence, missing class needn't put the student behind. Secondly, classroom interruptions needn't halt the momentum of the class. Thirdly, those who learn fast are not held up by the slower learners, and slower learners are not competing with the faster learners. Also, students of varying abilities and backgrounds can be accommodated in a single classroom. Interruptions affect only a single student, not the entire class. Lecturing and prepared classroom demonstrations are out, and the program runs itself.

McDonald also listed several disadvantages. First, the student is on his own and needs much self-motivation. Also, the materials must teach, but many materials are inefficient for teaching the process itself. The student still must be able to read. The teacher must go over the same concepts many times with different students at different times. Smaller classes are needed so that the teacher can explain different things at different times to different students. The brighter students may finish before the course ends and not want additional work. Many teachers miss the lecture teaching and don't like being clerks. Finally, students learn at their own natural rates, which may be less than desirable for the low-motivation students.

After weighing the pros and cons, many instructors chose to use individualized instruction in mathematics (Miller, 1976; Osborne, 1976; Willoughby, 1976). Dahlke (1975) studied the individual in an individualized course in arithmetic at a community college. Straley (1977) individualized instruction in a first-year algebra course.

Flexer (1978) compared lecture and laboratory strategies for teaching mathematics. Flexer's laboratory strategy referred to a mode of discovering mathematical concepts through explorations with manipulative materials such as dice, blocks, and balances. Flexer called this method learning by doing. Under the lecture strategy the material was presented in an expository manner. Although questions from the class were discussed, the primary role of the teacher under the lecture method was to transfer information efficiently. Under the laboratory strategy, students worked in groups manipulating materials. Written exercises and worksheets designed to guide students were available. The role of the teacher in the laboratory strategy was one of a consultant who answered questions and helped individual students.

The results of the study indicated that neither strategy, laboratory or lecture, was superior to the other based on achievement on tests, changes in attitudes toward mathematics, or effectiveness in teaching (Flexer, 1978). In addition, the student preferences were about equally divided between lecture and laboratory, which led Flexer to conclude that different teaching strategies suit different students. Flexer also suggested trying a course that combines the two strategies.

The combination of the two methods has been suggested by others. Schoen (1974) reported a program of mathematics instruction that combined the good points of the lecture method with individualized instruction. McLeod, Carpenter, McCormack, and Skoarcius (1978) stated, "Research in the learning of mathematics suggests that no single instructional treatment is likely to maximize learning for every student" (p. 163). They suggested that researchers design alternate treatments that are tailored to suit students with specific characteristics or aptitudes.

Curricula

After defining giftedness, identifying the gifted, and stating the characteristics of the gifted, the curricula can more logically be developed.

Stanley (1950) defined enrichment as "any educational procedures beyond the usual ones for the subject or grade or age that does not accelerate or retard the student's placement in the subject or grade" (p. 172). Stanley illustrated four types of enrichment in "Identifying and Nurturing the Intellectually Gifted." The first forms of enrichment might be termed busywork, which consists of more of the same, greater in quantity than is required of the average student in the class but with no difference in level. In describing enrichment by use of busywork, Stanley related the story of a mathematically precocious boy, an eighth grader with an IQ of 187 who had already skipped a grade, who was required by his Algebra I teacher to work every problem in each chapter rather than just the odd-numbered problems. Fortunately, the boy, oppressed by busywork in the beginning algebra course, after the eighth grade studied all of his mathematics part-time at the college level. He took college algebra and trigonometry, calculus, advanced calculus, linear algebra, and computer science as a high school student.

Not all stories end as happily, though. Rice (1980) pointed out that research confirmed the idea that gifted children, who typically have a voracious appetite for knowledge, need special separate attention to realize their full potential. "Recent studies conducted for the U.S. Office of

Education have shown that bright children forced to endure routine curricula may turn off, tune out, daydream, or become behavior problems" (Rice, 1980, p. 55). High-IQ children have mistakenly been diagnosed as emotionally disturbed or learning disabled. Several studies have found that 20% of high school dropouts are gifted students (Rice, 1980).

Stanley's (1950) second type of enrichment was irrelevant academic enrichment, which consists of setting up a special subject or activity to enrich the lives of some group of talented students but pays no attention to the specific nature of their talents. The activity may be a special class in social studies which the mathematical "whiz" may enjoy as a temporary relief from the general boredom of school, but it will not help his or her situation in the slow-paced math class.

The third type of enrichment is cultural. Although it might likewise be irrelevant to the direct academic needs of the intellectually gifted student, cultural enrichment seems more worthwhile than the first two.

Stanley identified the most desirable type of enrichment as relevant enrichment in which students are given advanced material or higher-level treatment of in-grade topics in areas of their special aptitudes. An example of relevant enrichment is mathematically able students having a unified, integrated, modern mathematics curriculum from kindergarten through 12th grade.

Stanley (1950) views all of the types of enrichment except cultural enrichment as horizontal because they are usually tied closely to a particular grade and are not meant to affect the age-in-grade status of the students. On the other hand, academic acceleration is vertical because it means moving the student up into a higher school level for the subject or into a higher grade level than the chronological age of the student warrants.

Skipping a grade is called grade acceleration, and allowing a seventh-grader to take algebra is called subject-matter acceleration. Entering college before completing high school is an example of grade-skipping. Scoring well enough on the calculus test of the national Advanced Placement Program to earn college credits is an example of subject-matter acceleration which could result in grade-skipping.

> Nearly all types of special education for gifted children fall into three basic categories: pull-out enrichment programs for selected students that meet once or twice a week during or after school, or on Saturday; accelerated classes that cover traditional academic subjects faster than usual; and independent research projects or internships. (Rice, 1980, p. 58)

Today, many programs use both familiar and unorthodox techniques to enrich or accelerate the normal educational process for gifted students. They participate in brainstorming sessions on local parking problems, building models of the cities of the future, and training to be circus performers; or they study college-level calculus in the junior high school; or they undertake independent research on urban archaeology; or they serve as full-time interns at local TV stations and law firms as high school seniors (Rice, 1980).

Figure 1 diagrams three approaches to curricula for the gifted. The first two (accelerate and enrichment) are just patches or vitamins. In the last curriculum (reconceptualize), programs are designed just for the needs of the gifted students. They need to communicate with each other under the leadership of qualified teachers who understand their needs and who are qualified to meet them. The gifted are capable of transfer and generalization and of a higher level of abstraction. The curriculum should be designed with this in mind (Lucito, 1977).

It is the responsibility of educators to take all students and develop their individual potentials, especially the gifted. Curriculum, materials, and methods for teaching the gifted should be developed and used (Lucito, 1977).

Summary

Defining giftedness, listing characteristics of the gifted, identifying the gifted, and developing teaching methods and curricula for the gifted are all interrelated topics. This chapter presented a discussion of these topics and a review of related literature on computing. In the next chapter the methodology of the study is revealed.

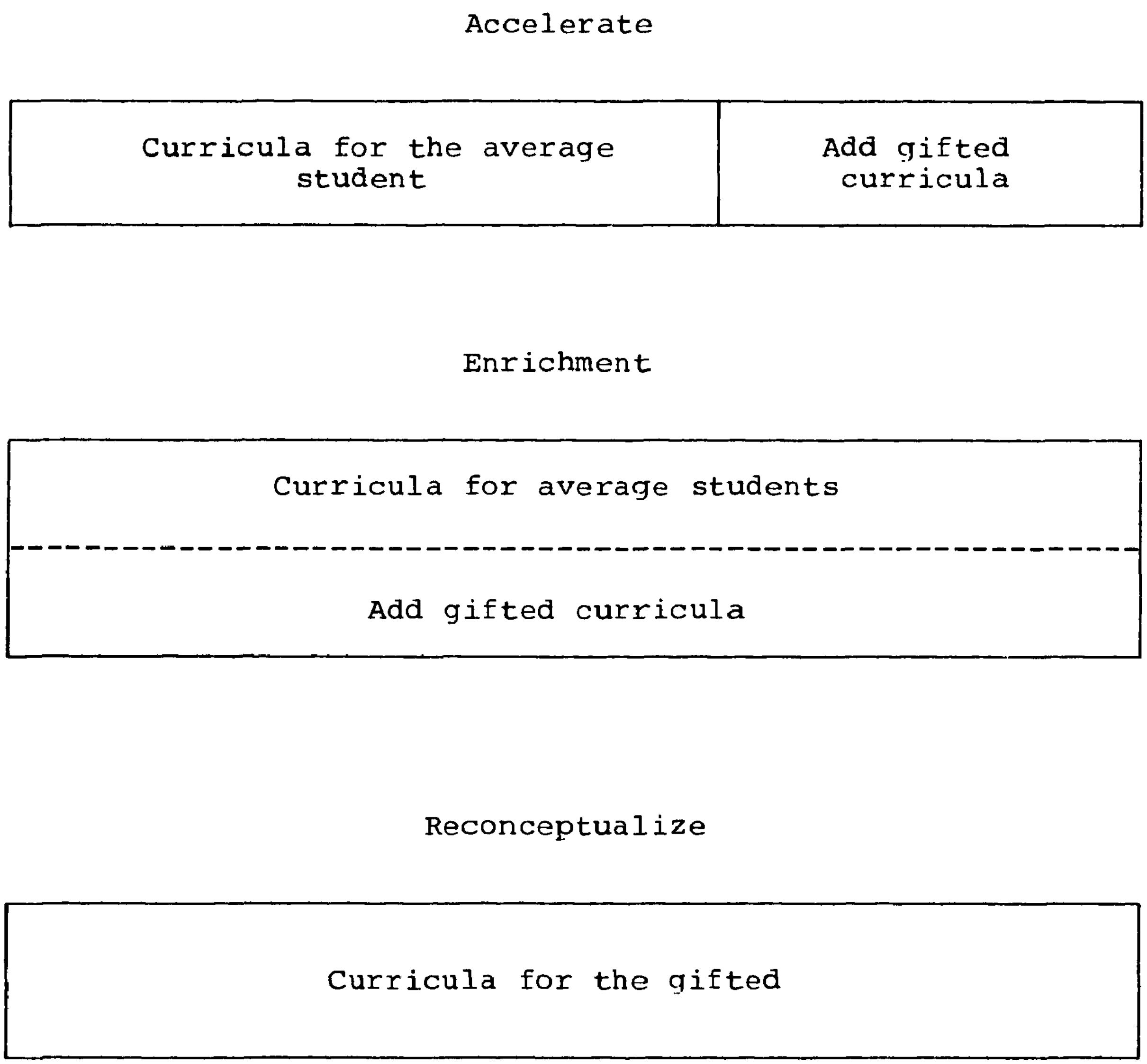

Figure 1. Three approaches to curricula for the gifted.

Chapter 3

METHODOLOGY

This chapter discusses the subjects, pilot studies, procedures, instruments, and evaluation. The research questions and hypotheses are also stated. The following section describes the subjects.

Subjects

The subjects for the study were the mathematics students in the summer 1979 Governor's Honors Program (GHP) at Macon, Georgia. These gifted secondary students from throughout the State of Georgia were selected for GHP by a multiphase screening process beginning at the school level, continuing through the system level, and ending at the state level. At the final screening, a reviewing panel of educators assessed the students' standardized test scores, transcripts, teacher recommendations, and student statements. Afterward, the panel members interviewed the students to determine their ambition, creativity, and potential. The interview procedure is contained in Appendix A.

By this screening process 600 students were chosen to participate in the program, 200 in Dahlonega and 400 in Macon, with 93 in mathematics. This residential program lasted only six weeks. The students selected in mathematics in Macon had not only morning major area in mathematics but also afternoon interest areas in many different things from bridge to golf. Also, many evening activities from music concerts and productions by the drama department to disco dances were planned for the students. Therefore, the student's time was at a premium. Furthermore, there was very limited time to teach the courses with only eight planned meetings approximately one hour each in duration. The major question to be answered was: Will more knowledge of the computer be gained with more of the students' time being taken up in lecture or will more be gained with hands-on experience on the computer? This question was formulated from the several pilot studies discussed in the next section.

Pilot Studies

The concern for finding the more efficient method for learning computer programming arose from the teaching of a computer course to beginning students with no computer experience. Such a computer course was first implemented by the investigator during the spring quarter of 1975 at Arlington High School, a small, private, college preparatory school. A prerequisite of Algebra II was required so that the students had been exposed at least once to the concepts in the computer book which was used. The course was a good review with the aid of the computer. Many of the concepts such as limit were taught easier with the help of the computer outputs. In this course, lecture was used on each chapter of the book. In the spring of 1976 the course was offered again, but during the same class period several of the students from the preceding course were taking an advanced computer course for which the investigator had developed teaching materials. As a result, the investigator's time had to be split between the two groups, and less time was available for lecture.

The course was taught again in the summer of 1977 to the mathematics students at the Governor's Honors Program (GHP) in Macon, Georgia--two classes the first three weeks of the program and one class the second three weeks. During the classes that met the first three weeks, some lecture was used. During the class that met the second three weeks, an overwhelming majority of the class did not want lecture. They stated that they would rather spend their time on the computer, and they seemed to progress as well as the two other classes had.

The course was taught again at Arlington Schools in the spring of 1978 and 1979, with little lecture used. Some of the students tested very well without the lecture; but the poorer students, even though they had written and run the programs, did not score well on the tests over the material without the aid of lecture. There seemed to be a strong correlation between student ability and the ability to perform well on the tests without lecture.

During the summer of 1978 the course was taught again at GHP under the assumption that these students did not need the lecture or much structure because of their high ability. Because of this assumption very little lecture was used. During the student evaluation many of the students said that they had enjoyed the freedom to work at their own rate with little structure, but others wanted more lecture and structure. Because of the nature of GHP there had been no testing during any of the courses to measure ability to program a computer at the completion of the course. There seemed to the investigator to be a need to compare two methods of instruction, one with group instruction and one without, and to try to predict which students would progress better under which method. From these pilot studies and much thought the idea for this study arose.

Procedures

The three stages of this study were the design stage, the implementation stage, and the evaluation stage. The stages are discussed in the next three sections.

Design

During the first stage, the investigator reviewed the previously discussed pilot studies and subjects and developed a feasible experimental design.

Experimental Design

The experimental design decided on was a multigroup pretest-posttest design with two treatment groups. The students with no computer experience were randomly assigned to one of the treatment groups. The control group consisted of the students with prior computer experience. Each student in the two treatment groups and the control group was given a pretest and a posttest of several different tests. One of the treatment groups was scheduled for a class in beginning computer programming in which little or no direct group instruction was given, and the other treatment group was scheduled for a class in beginning computer programming in which direct group instruction was used each class meeting. The students in the control group did not take either beginning computer course, but many of them took an advanced computer course as an interest area.

Huck, Cormier, and Bounds (1974) classified this design as an extension of the pretest-posttest control group true experimental design. The groups differ only in what happens to the subjects between the pretest and the posttest. The groups that receive the treatments (independent variables) are called the experimental or treatment groups; the group which does not receive the treatment is called the control group (Huck et al., 1974).

The first treatment group (T_1) consisted of the students with no computer experience who took the computer class with little or no direct group instruction. The second treatment group (T_2) was designed to accommodate students with no computer experience who took the computer class with direct group instruction each class period. The control group (C) consisted of the students with computer experience, those who had written and run programs.

Several instruments were given to each student both as a pretest and a posttest. A discussion of the instruments is presented next.

Instruments

Several instruments used in this study were given as both a pretest and a posttest:

1. the View of Mathematics Inventory (VMI), revised to read "computer science" instead of "mathematics";
2. the Barron Independence of Judgment (BIJ) Scale;
3. the Internal-External Locus of Control (LOC); and
4. the Test of Computer Programming Ability (TCA).

Two instruments were given as pretests only: (1) a Test of Prerequisite Knowledge (TPK), and (2) a Student Information Profile (SIP). In addition, a record of the number of programs each student completed was kept, and an attempt was made to measure the amount of time each student spent on the computer. A questionnaire on which teaching method each student preferred was filled out both before the classes began and after their completion. Each of these instruments is contained in Appendix B and described in the following paragraphs.

The View of Mathematics Inventory (VMI). The View of Mathematics Inventory was developed by William Rettig, Sr., in 1972 and revised by John P. Downes and Thomas Thomson in

1975 to assess attitudes toward mathematics. This instrument was revised to read "computer science" instead of "mathematics" by Leonard Lucito and the investigator and was used as a pretest and posttest for the two treatment groups and the control group to evaluate the students' attitudes toward computer science.

The first version of the VMI developed by Rettig consisted of 100 items. Downes and Thomson's revised version is a 35-item Likert-type test with reported reliability estimate of .70 using the Kuder-Richardson 21 (KR-21) for 37 subjects (Thomson, 1976, p. 148). On the VMI, the students rated the 35 items as follows: strongly agree (SA), agree (A), neutral (N), disagree (D), and strongly disagree (SD). A copy of the VMI can be found in Appendix B.

Barron Independence of Judgment Scale (BIJ). The Barron Independence of Judgment Scale consists of 22 true-false items devised by Barron (1953, 1965, 1968) and based on the work of Asch (1952). In 1952 Barron used 200 items thought to relate to independence of judgment to develop a criterion-specific questionnaire. Barron and Asch reduced the list of statements to 84 which were tested on a group of third-year college students who had been identified in experiments conducted by Asch as being "independents" or "yielders." From the results 22 items were chosen for Barron's instrument because they discriminated the subjects of Asch who demonstrated independence of judgment.

This 22-item instrument, for which Barron and Asch showed the first 9 items each significant at the .01 level and the last 13 at the .05 level, was administered to the GHP mathematics students as both a pretest and a posttest. The test, which appears in Appendix B, is scored 0-22 with 22 indicating the greatest independence of judgment.

The Internal-External Locus of Control (LOC). Rotter developed the Internal-External Locus of Control which is an instrument of 29 items. The scale is a forced-choice inventory to determine whether the subjects view their lives as being controlled by internal or external forces. Split-half and Kuder-Richardson reliabilities of the 29-item scale cluster around .70, and retest reliabilities after intervals of one or two months are at the same level (Anastasi, 1976).

This instrument was revised by Leonard Lucito and the investigator to be more school and teacher related. For example, part of the first item read "Children get into trouble because their parents punish them too much." This statement was modified to read "Students get into trouble because their teachers punish them too much." This revised scale is contained in Appendix B and was administered to the two treatment and the control groups as both a pretest and a posttest.

The Test of Computer Programming Ability (TCA). In order to evaluate the student's ability to program a computer in the BASIC language, the investigator developed a test which was given as both a pretest and a posttest to all of the mathematics students. The test required 40 answers on writing the output of given programs, debugging given programs, and writing the purpose of given programs and certain lines. The test was constructed to be relatively simple due to the very limited time available for the computer courses. The test is included in Appendix B.

The Test of Prerequisite Knowledge (TPK). The investigator also developed a Test of Prerequisite Knowledge to ascertain the topics in the computer course to which the students have been exposed. The test consisted of 10 items requiring 20 answers on the following topics: functions, slope of a line, equation of a line, multiplicative inverse of a matrix, quadratic formula, zeros of a function, sum, difference, product, and quotient of complex numbers, limit of sequences, arithmetic and geometric progressions, and factorials. The Test of Prerequisite Knowledge, contained in Appendix B, was administered as a pretest only.

Student Information Profile (SIP). The Student Information Profile was designed by the investigator as a pretest only to obtain important information about each student. Some of the information requested was the following: name, age, sex, size of city of residence, size of school attended, class, knowledge of the concepts also covered in the Test of Prerequisite Knowledge, ability to use both nonprogrammable and programmable calculators, and ability to program a computer. The Student Information Profile is presented in Appendix B.

Implementation

The computer programming course was taught to four different classes; two classes were taught with little lecture directly by the textbook, Computer Assisted Mathematics--Intermediate Mathematics, published by Scott, Foresman, and Company. A checklist was given out to each student with a listing of the programs to be written and run. These courses were geared toward independent study with the teacher acting as a consultant. The students were assigned particular programs from the text to be written and run. These programs had been previously run by the teacher for quick and easy checking. Little or no lecture was given. The students were encouraged to work at their own rate, asking questions when necessary. The list of programs is contained in Appendix B.

The chapters in the textbook covered the following topics: what is a computer, the history of computers, the concept of a function as related to the computer, linear and quadratic functions computer style, the computer and complex numbers, the matrix meets the computer, the computer and trigonometry, sequences, series, and limits.

The other two courses which had more teacher instruction covered essentially the same topics but entailed some lecture each day, with planned activities and handouts to aid in the learning of how to write a program. The course outline for the classes with little direct classroom instruction and the handouts for the classes with direct classroom instruction each class meeting are contained in Appendix C.

The Governor's Honors Program (GHP) mathematics students for the summer of 1979 used in the study totaled 93. Each faculty member presented the courses that he or she wished to teach to the students in a short, two- or three-minute summary. Each student without previous experience in computer programming was encouraged to take one of the computer courses, and each student chose computer programming as one of their first four class choices. There were 60 students with very little or no computer background. These were assigned to one of four computer classes by means of a random number table generated on the computer. The results yielded totally random classes with 15 students in Class 1, Class 2, Class 3, and Class 4.

Each class met 8 times for 1 hour and 20 minutes for a total of 10 hours and 40 minutes, with Classes 1 and 2 meeting one day and Classes 3 and 4 the next. Because of the many activities at GHP the schedule varied from day to day. Appendix C contains a breakdown of the meeting days for each class. The remaining time was filled with directed study projects, speakers, a field trip, field day, and other activities such as preparing for casino. Therefore, each class met on different days during the summer. The first class of the day met from 8:30 to 9:50 and the second from 10:10 to 11:30 in the morning.

Classes 1 and 4 were taught with little group instruction and Classes 2 and 3 were taught with group instruction daily. Class 1 usually met during the early time slot and Class 4 during the late time slot, likewise for Classes 3 and 2, so that the time of day would not be a factor.

The 30 students in Classes 1 and 4 who received little group instruction were the first treatment group (T_1), the 30 students in Classes 2 and 3 who received daily group instruction were the second treatment group (T_2), and the remaining 33 students with prior computer experience were the control group (C) for the study.

The agenda for the first class meeting for all four classes follows: call roll; tell students the method used in teaching the class; tell students the rules for the class; discuss the programs previously hung around the room; discuss uses of the computer; give out books and list of programs to Classes 1 and 4; discuss and recommend reading the February 20, 1978, Time magazine on "The Computer Society"; pass out ditto about the Univac computer that the students would be using; go over logon and logoff procedures; logon and run a short program previously stored; and logoff.

The second class for Classes 1 and 4 consisted of going over the first program on the list from the book and then letting the students work on the computer. The second class for Classes 2 and 3 was spent going over overhead projector transparencies on the topics on Handouts 2, 3, and 4. All classes were given Handouts 5, 6, and 7. Classes 2 and 3 were assigned the exercises on Handout 8.

The third class meeting Classes 1 and 4 wrote and ran programs from their list, and Classes 2 and 3 discussed the programs on Handout 8 and were assigned five more programs on Handout 9.

During the fourth class meeting of Classes 1 and 4 the investigator checked with everyone in the class and recorded the number of programs completed while the students worked on the computer. The instructor also encouraged all students to have at least ten programs written, run, and checked off by the next class meeting. In Classes 2 and 3 the fourth meeting consisted of discussing programs previously assigned, slope of a line, equation of a line given two points, equation of the inverse, the quadratic formula, and adding, subtracting, multiplying, and dividing complex numbers. In addition, three more programs were assigned on Handout 10, and students were encouraged to have all 13 programs assigned checked off by the next class meeting.

For the fifth class Classes 1 and 4 ran programs. Classes 2 and 3 discussed programs and filled in the exercise on the quadratic formula, complex numbers, and slope on Handouts 11 and 12. The instructor then discussed continuous functions, approximating roots on the computer by looking for sign changes, and solving a system of equations using matrices. The exercises on Handout 13 were assigned.

During the sixth class Classes 1 and 4 again ran programs, asking the instructor for help only when it was needed. The sixth class for Classes 2 and 3 consisted of working and discussing Handouts 14, 15, and 16. Then factorials, sequence, series, and partial sums were discussed by the instructor with the aid of Handout 17.

For the seventh class Classes 1 and 4 ran programs while Classes 2 and 3 went over Handouts 18, 19, and 20.

The eighth class was the same for all four classes. The students went over the limit programs they had run to see how the computer can be used to help guess the limit of a sequence. The instructor went over four programs illustrating how the computer can be used to do mathematics. The remaining time was spent by the students running programs on the computer.

Classes 1 and 4 were given most of their class time to run their programs, while Classes 2 and 3 were given very little class time for the running of programs. The computer room was open every night from 6:00 until 10:45 and every weekend to all students to come and run programs. A record of all programs written and run correctly by each student at whatever time the student worked on the computer was kept by the investigator. A description of the other data collection is discussed next.

In addition to a record of the number of the 21 assigned programs completed by each student, many other measures were used. All 93 students assembled before the first class meeting and filled out a Student Profile Questionnaire. The students then took pretests on the View of Mathematics Inventory (VMI), the Barron Independence of Judgment (BIJ) Scale, the Internal-External Locus of Control (LOC), the Test of Computer Programming Ability (TCA), and the Test of Prerequisite Knowledge (TPK). After the last class meeting all 93 students were again assembled and all of the instruments except the Student Profile Questionnaire and the Test of Prerequisite Knowledge were administered as posttests. During the first and last class meeting of all four computer classes, the 60 students filled out a questionnaire on which teaching method they preferred: (a) little or no group instruction, or (b) group instruction daily. An attempt was also made to keep a record of the amount of time each student spent on the computer by means of a sign-in and -out sheet. All these instruments are contained in Appendix B.

A discussion of the evaluation, including research questions, hypotheses, and data analysis, is considered next.

Evaluation

The evaluation section contains the research questions, the hypotheses, and the data analysis.

Research questions. From the problem statements the following research questions were generated.

1. Did either treatment change the students' independence of judgment, abilities to program the computer, attitudes toward computer science, and/or locuses of control?

2. Is it possible to predict the score on the posttest of computer ability of the student?

3. Is it possible to predict the number of programs the student will complete?

4. Does a person's sex affect his ability to learn computer programming and/or attitudes toward computer science?

5. Does a person's knowledge of programmable calculators affect his ability to learn computer programming?

Hypotheses. From Research Question 1 the following hypotheses were formed.

1. There is no significant difference between the adjusted means of the scores generated by the Barron Test of Independence of Judgment (BIJ) for the two treatments and the nontreatment groups.

2. There is no significant difference between the adjusted means of the scores generated by the Test of Computer Ability (TCA) for the two treatments and the nontreatment groups.

3. There is no significant difference between the adjusted means of the scores generated by the View of Mathematics Inventory (VMI) as modified to be view of computer science for the two treatments and the nontreatment groups.

4. There is no significant difference between the adjusted means of the scores generated by the Internal-External Locus of Control (LOC) for the two treatments and the nontreatment groups.

Based on Research Question 2 the following hypotheses were constructed.

5. There is no association between the posttest scores of the Test of Computer Ability (TCA) and the scores for the

Barron Test of Independence of Judgment (BIJ), View of Mathematics Inventory (VMI), or Internal-External Locus of Control (LOC).

6. There is no relationship between the posttest scores generated by the Test of Computer Ability (TCA) and the scores for the Barron Test of Independence of Judgment (BIJ), View of Mathematics Inventory (VMI), or Internal-External Locus of Control (LOC).

From Research Question 3 the following hypotheses were written.

7. There is no association between the number of computer programs run and the scores for the Barron Test of Independence of Judgment (BIJ), View of Mathematics Inventory (VMI), or Internal-External Locus of Control (LOC).

8. There is no relationship between the number of computer programs run and the scores for the Barron Test of Independence of Judgment (BIJ), View of Mathematics Inventory (VMI), or Internal-External Locus of Control (LOC).

9. There is no relationship between posttest scores on the Test of Computer Ability (TCA) and the number of programs run.

Research Question 4 gave rise to the following hypotheses.

10. There is no relationship between a person's sex and his posttest scores on the Test of Computer Ability (TCA) and/or the number of programs run.

11. There is no relationship between a person's sex and the View of Mathematics Inventory (VMI).

Research Question 5 generated the following hypothesis.

12. There is no relationship between those who have or have not programmed calculators and the posttest scores on the Test of Computer Ability (TCA) and/or the number of programs run.

Data analysis. Twelve hypotheses and five research questions were stated in the previous section of this chapter. These hypotheses aided in the evaluation of this study. Chapter 4, Results and Discussion, contains the statistical analyses in conjunction with each hypothesis.

This chapter described the subjects, pilot studies, procedures, instruments, and evaluation of the study. The statistical analyses of the hypotheses identified in the chapter are discussed in the next chapter.

Chapter 4

RESULTS AND DISCUSSION

This chapter contains a summary of the statistical analyses and discussions of the related research questions. Significant findings are summarized at the end of this chapter. Also, threats to external and internal validity are discussed.

Scores generated by the instruments described in Chapter 3 were used as measures of the constructs in question. The instruments and constructs used in the study include: the View of Mathematics Inventory (VMI), view of mathematics; the Barron Independence of Judgment Scale (BIJ), independence of judgment; the Internal-External Locus of Control (LOC), locus of control; the Test of Computer Programming Ability (TCA), ability to program a computer; the Test of Prerequisite Knowledge (TPK), knowledge of mathematical concepts used in the computer programs; a Student Information Profile (SIP), general information about each student; and the Number of Computer Programs Completed (NPC), the number of computer programs completed.

The following nominal data were gleaned from the SIP: student's sex (SEX), the size of the city from whence the student came (CITY SIZE), the last year the student completed in high school, sophomore or junior (CLASS), and whether or not the student had worked with a programmable calculator (PROGRAMMABLE). In addition, after randomly placing students into treatment groups, the students' preferences as to teaching methods were obtained both before and after treatment (TPPRE and TPPOST). Scores denoted as SEX, CITYSIZE, CLASS, PROGRAMMABLE, TPPRE, and TPPOST were treated as nominal data and were used in nonparametric statistical tests.

Scores obtained from the VMI, BIJ, LOC, TCA, TPK, and NPC were treated as interval data. Although scores generated by the VMI, BIJ, and LOC are, strictly speaking, ordinal in nature, they approximate interval data fairly well. According to Kerlinger (1973), "The best procedure would seem to be to treat ordinal measurements as though they were interval measurements, but to be constantly alert to the possibility of gross inequality of intervals" (p. 441).

In addition to the assumption that data are interval in nature, data must be approximately normally distributed in order to use parametric statistical tests. All the distributions of scores were examined. The assumption of normality was met by scores generated by the VMI, BIJ, LOC, TCA, TPK, and NPC. For each of these distributions of scores in each treatment group and in the control group, the values for skewness were near zero and the values for kurtosis were near three. The percentages of observations within one, two, and three standard deviations from the mean also indicated normality. In addition, the mean and median of each distribution were approximately the same. Therefore, parametric statistical tests were used to analyze hypotheses that used scores from the VMI, BIJ, LOC, TCA, TPK, and NPC.

Major Findings

In this section each research question is restated, the related hypotheses are analyzed, and the research questions are discussed.

Research Question 1

Research Question 1. Did either treatment change the students' independence of judgment, ability to program the computer, attitude toward computer science, and/or locus of control? There are four hypotheses that are related to the first research question.

Hypothesis 1. There is no difference between the adjusted means of the scores generated by the Barron Test of Independence of Judgment (BIJ) for the treatment and non-treatment groups.

Analysis of covariance was used to analyze Hypothesis 1. Since it was necessary to control for initial differences among the groups (two treatment groups and one control group), the pre-BIJ was used as the covariate [$F(87,5) = 15.056$, $p < .001$]. There is no interaction between pre-BIJ and post-BIJ; therefore, the covariate and variate are linearly related [$F(87,2) = .253$, $p > .05$]. All inherent assumptions for the analysis of covariance model have been met (Winer, 1971, p. 764).

There is insufficient evidence to reject Hypothesis 1, that the treatments shifted the scores of the Barron Test of Independence of Judgment [$F(87,2) = .4995$, $p > .05$]. Table 1 records the analysis of covariance for Hypothesis 1.

Hypothesis 2. There is no difference between the adjusted means of the scores generated by the Test of Computer Ability (TCA) for the treatment and nontreatment groups.

In an attempt to use the analysis of covariance model for Hypothesis 2, the assumptions for this model were tested. It was found that the covariate (pre-TCA) and the variate (post-TCA) are not linearly related [$F(87,2) = 5.74$, $p < .001$]. Therefore, the inherent assumption of linearity for the analysis of covariance model is not met (Winer, 1971, p. 754). The results of this analysis are presented in Table 2.

In order to determine if treatment changed the students' abilities to program the computer, separate t tests were computed between the covariate and the variate for each of the treatment groups and the nontreatment (control) group. The results are reported in Table 3.

There is sufficient evidence to reject Hypothesis 2 based on the t statistic ($p < .0005$ for the treatment groups and $p < .01$ for the nontreatment group).

Hypothesis 3. There is no difference between the adjusted means of the scores generated by the View of Mathematics Inventory (VMI), which was modified to be view of

Table 1

Analysis of Covariance with Post-BIJ as the Variate and Pre-BIJ as the Covariate

Sources of Variation	Sum of Squares	*df*	*MS*	*F*
Due to Total Model	313.185	5	62.637	15.056
Due to Additive Model	311.078	3	103.693	24.925
Due to Variate	4.156	2	2.078	.499
Due to Covariate	244.854	1	244.854	70.876
Due to Interaction	2.106	2	1.053	.253
Residual	361.933	87	4.160	

Table 2

Analysis of Covariance with Post-TCA as the Variate and Pre-TCA as the Covariate

Sources of Variation	Sum of Squares	*df*	*MS*	*F*
Due to Total Model	1452.472	5	290.494	8.699
Due to Additive Model	1069.091	3	356.36	10.671
Due to Variate	769.903	2	384.951	11.528
Due to Covariate	1043.576	1	1043.576	31.250
Due to Interaction	383.381	2	191.691	5.74
Residual	2905.355	87	33.394	

Table 3

Results of the Comparison of Pre-TCA with Post-TCA by Treatment and Nontreatment Groups

Group	*t* Statistic	*p*
Treatment 1	13.7723	< .0005
Treatment 2	19.5644	< .0005
Control	3.49	< .01

computer science, for the treatment and the nontreatment groups.

In response to Hypothesis 3, an analysis of covariance was used. It was necessary to control for initial differences; therefore, the pre-VMI was used as the covariate [$F(87,5) = 5.26$, $p < .001$]. Also, it was found that the variate and covariate are linearly related [$F(87,2) = 1.403$, $p > .05$]. All assumptions for the analysis of covariance model were met (Winer, 1971, p. 764).

There is insufficient evidence to reject Hypothesis 3 [$F(87,2) = .256$, $p > .05$]. Table 4 records the analysis of covariance model.

Hypothesis 4. There is no difference between the adjusted means of the scores generated by the Internal-External Locus of Control (LOC) for the treatment and non-treatment groups.

Analysis of covariance was used to test Hypothesis 4. The pre-LOC was used as the covariate [$F(87,5) = 18.949$, $p < .001$]. Pre-LOC and post-LOC are linearly related [$F(87,2) = 1.7443$].

There is insufficient evidence to reject Hypothesis 4 [$F(87,2) = 1.671$, $p > .05$]. Table 5 records the results.

Discussion of Research Question 1. The results of Hypotheses 1, 3, and 4 show that the students did not change in independence of judgment, view of computer science, or locus of control. According to Hypothesis 2, both treatment groups became better computer programmers. In addition, the

Table 4

Analysis of Covariance with Post-VMI as the Variate and Pre-VMI as the Covariate

Sources of Variation	Sum of Squares	*df*	*MS*	*F*
Due to Total Model	1903.355	5	380.671	5.26
Due to Additive Model	1700.473	3	566.824	7.839
Due to Variate	37.075	2	18.537	.256
Due to Covariate	1513.777	1	1513.777	20.936
Due to Interaction	202.882	2	101.441	1.403
Residual	6290.344	87	72.303	

Table 5

Analysis of Covariance with Post-LOC as the Variate and Pre-LOC as the Covariate

Sources of Variation	Sum of Squares	*df*	*MS*	*F*
Due to Total Model	604.746	5	120.949	18.949
Due to Additive Model	582.478	3	194.159	30.418
Due to Variate	21.331	2	10.666	1.671
Due to Covariate	564.859	1	564.859	88.494
Due to Interaction	22.268	2	11.134	1.744
Residual	555.318	87	6.383	

nontreatment group became more efficient. This increase in the nontreatment group could be caused by three factors. First, the interaction between the students in the two treatment groups and the nontreatment group could have caused the increase. Because of the residential nature of GHP, communication between students was not only inevitable but also encouraged. Students from the entire campus used the computer room at night and on weekends. Second, many of the students in the nontreatment group of students with prior knowledge of computers took a computer course as an interest area. Third, many students in the nontreatment group did directed study in computer programming during major area time.

Because of the significant levels for the two treatment groups, both treatments did increase knowledge of computer programming.

Research Question 2

Research Question 2. Is it possible to predict the posttest score on the test of computer ability of the student? Hypotheses 5 and 6 address this research question.

Hypothesis 5. There is no association between the posttest scores on the Test of Computer Ability (TCA) and the scores for the Barron Test of Independence of Judgment (BIJ), the View of Mathematics Inventory (VMI), or Internal-External Locus of Control (LOC).

Pearson's correlation coefficients were generated to analyze Hypothesis 5. Pairwise, all variables are linearly related; therefore, Pearson's correlation coefficients are appropriate.

For all correlations, there is insufficient evidence to reject Hypothesis 5. No correlation coefficient was found to be significant ($p < .05$). Table 6 summarizes the results.

Hypothesis 6. There is no relationship between the posttest scores generated by the TCA and the scores for BIJ, VMI, or LOC.

The appropriate statistical test is a stepwise multiple regression. However, since there is insufficient evidence to reject Hypothesis 5, there is no significant prediction equation. Therefore, there is insufficient evidence to reject Hypothesis 6.

Discussion of Research Question 2. Based on Hypotheses 5 and 6, it is not possible to predict the posttest score on the Test of Computer Ability based on the view of computer science, locus of control, or independence of judgment.

Research Question 3

Research Question 3. Is it possible to predict the number of programs the student will complete? Hypotheses 7, 8, and 9 were used to assess this question.

Hypothesis 7. There is no association between the number of computer programs run and the scores for BIJ, VMI, or LOC.

Pearson's correlation coefficients were used to assess this hypothesis. Pairwise, all scores are linearly related.

Table 6

Pearson's Correlation Coefficients

for Hypothesis 5

	Treatment 1 Post-TCA (n = 30)	Treatment 2 Post-TCA (n = 30)	Nontreatment Post-TCA (n = 33)
Pre-BIJ	.2085	.1985	.0698
Post-BIJ	.2341	.1421	-.0344
Pre-LOC	.1858	-.0023	.1971
Post-LOC	.1855	.1491	.1437
Pre-VMI	.2011	.3180	.0097
Post-VMI	.3516	.2123	.0291

Two correlations were found to be significant. For Treatment 2, there is an association between scores generated by the VMI and the number of computer programs run. The correlation between pre-VMI and post-VMI is .5978 ($p < .001$) for Treatment 2; therefore, it is not unusual for the NPC to be related to both the pre-VMI and the post-VMI.

For the remaining correlations there is insufficient evidence to reject Hypothesis 7. Table 7 records the results.

Hypothesis 8. There is no relationship between the number of computer programs run and the scores for BIJ, VMI, or LOC.

Stepwise multiple regressions were used to analyze this hypothesis. Since no correlation pairwise between the independent variables (pre-BIJ, post-BIJ, pre-VMI, post-VMI, pre-LOC, and post-LOC) was found to exceed .80, colinearity is not a factor (Mosteller, 1977).

For Treatment 2, the number of computer programs completed (NPC) can be predicted by the following equation:

$$\widehat{NPC} = .4948 \text{ Post-VMI} + .7757 \text{ Post-LOC} + .6831 \text{ Post-BIJ} - 53.16253$$

The multiple correlation coefficient is .76614 ($p < .0001$), showing that 58.7% of the score denoted as NPC can be statistically explained by the independent variables post-VMI, post-LOC, and post-BIJ. The standardized Beta weights for post-VMI, post-LOC, and post-BIJ are .70182, .37509, and .31717, respectively. Table 8 records the analysis of variance table for this regression.

Table 7

Pearson's Correlation Coefficients

for Hypothesis 7

	Treatment 1 NPC	Treatment 2 NPC
Pre-BIJ	-.1286	-.0382
Post-BIJ	-.1223	.1044
Pre-VMI	-.0014	.4960*
Post-VMI	-.0372	.6662**
Pre-LOC	-.0251	.0082
Post-LOC	-.0502	.2302

*$p < .001$

**$p < .0001$

Table 8

Analysis of Variance for Regression Model

for Treatment 2

Sources of Variation	Sum of Squares	*df*	*MS*	*F*
Regression	644.41286	3	214.80429	12.3164
Residual	453.45381	26	17.44053	

Therefore, there is sufficient evidence to reject Hypothesis 8 for Treatment 2. Since in Hypothesis 7 there is no significant correlation for Treatment 1, there is not sufficient evidence to reject Hypothesis 8 for Treatment 1.

Hypothesis 9. There is no relationship between scores on the TCA and number of programs run (NPC).

The variables are linearly related; therefore, Pearson's correlation coefficients were computed to assess this hypothesis. For both Treatment 1 and Treatment 2, there is a significant correlation (p < .01) between NPC and post-TCA, .4193 and .4974, respectively. In addition, for Treatment 1 there is a significant correlation between NPC and pre-TCA (.3306, p < .05). Therefore, there is sufficient evidence to reject Hypothesis 9. Additionally, the correlations between pre-TCA and post-TCA for Treatment 1 and Treatment 2 were checked and found to be .2308 and .2673, respectively (not significant, p > .05). Table 9 records the results of Hypothesis 9.

Discussion of Research Question 3. The number of programs run can be predicted by the post-BIJ, the post-VMI, and the post-LOC for Treatment 2. For Treatment 1 none of the scores from pre-VMI, post-VMI, pre-LOC, post-LOC, pre-BIJ, or post-BIJ predicted the number of programs run. For Treatment 2 58.7% of the score called NPC could be predicted by the post-VMI, the post-BIJ, and the post-LOC.

There is a relationship between the number of programs run and both the pretest and posttest of the Test of Computer

Table 9

Pearson's Correlation Coefficients

for Hypothesis 9

	Treatment 1 NPC	Treatment 2 NPC
Pre-TCA	.3306*	.0520
Post-TCA	.4193**	.4974**

*$p < .05$

**$p < .01$

Ability for Treatment 1. There is a relationship between the number of computer programs run and the posttest scores on the Test of Computer Ability for Treatment 2. Therefore, the pretest scores of the Test of Computer Ability could be used to predict the number of programs run for Treatment 1.

Research Question 4

Does a person's sex affect his ability to learn computer programming and/or attitudes toward computer science? Hypotheses 10 and 11 address this research question.

Hypothesis 10. There is no relationship between a person's sex and his posttest scores on the Test of Computer Ability (TCA) and/or the number of programs run.

Discriminant analysis was used to analyze this hypothesis. The variables post-TCA and NPC were used as discriminants to separate students by sex.

There is insufficient evidence to reject Hypothesis 10. Table 10 records the results.

Hypothesis 11. There is no relationship between a person's sex and his score on the VMI.

Discriminant analysis was used to assess Hypothesis 11. The scores on the post-VMI could not discriminate sex (Wilks' Lambda of .9850, $p > .05$). Therefore, there is insufficient evidence to reject Hypothesis 11.

Discussion of Research Question 4. Based on Hypotheses 10 and 11, a person's sex does not affect his or her ability to learn computer programming and/or attitudes toward computer science.

Table 10

Discriminant Analysis to Predict Sex

Variable	Wilks' Lambda	*F*
Post-TCA	.98378*	.9564
NPC	.99248*	.4395

*p > .05, not significant

Research Question 5

Research Question 5. Does a person's knowledge of programmable calculators affect his ability to learn computer programming? Hypothesis 12 was used to analyze this question.

Hypothesis 12. There is no relationship between those who have or have not programmed calculators and the posttest scores on the Test of Computer Ability (TCA) and/or the number of programs run.

Discriminant analysis was used to assess Hypothesis 12. The variables post-TCA and NPC were used as discriminants to separate students by previous knowledge of programmable calculators.

There is insufficient evidence to reject Hypothesis 12. Table 11 records the results.

Discussion of Research Question 5. Based on Hypothesis 12, a person's knowledge of programmable calculators does not affect his ability to learn computer programming. However, there were only 5 out of 60 members of the treatment groups who had used programmable calculators; hence, this result has no meaning.

Threats to Validity

Internal validity, which addresses the causes of relationships, and external validity, which includes the ability to generalize results, are two criteria for evaluating the validity of a study of this nature. Threats to these two

Table 11

Discriminant Analysis to Predict Knowledge of Programmable Calculators

Variable	Wilks' Lambda	*F*
Post-TCA	.99988*	.007055
NPC	.97756*	1.331

*p > .05, not significant

types of validity are an aid in defining the limitations of this investigation. These threats, as they relate to this study's design and implementation, are discussed in the following sections.

Threats to Internal Validity

The experimental design used in this investigation is classified as a true experimental design and is identical to the pretest-posttest control group design (Huck et al., 1974, pp. 270-273). "The only threat to internal validity that is not controlled by the pretest-posttest control group design is mortality" (Huck et al., 1974, p. 246). Since there were no cases of mortality during the course of the experiment, the threats to internal validity have been satisfied.

Threats to External Validity

There are two broad classifications of external validity, population validity and ecological validity.

> Population validity concerns the generalization of the results to other subjects; ecological validity concerns the generalization of the results to other settings or environmental conditions similar to the experimental setting or condition. (Huck et al., 1974, p. 258)

It seems reasonable to assume that the experimentally accessible population, the mathematics participants at the Governor's Honors Program, Macon, Georgia, is representative of the target population, Governor's Honors Program mathematics participants. This assumption is based on the GHP mathematics participants selection process and these students' characteristics, both of which are given in Chapter 3. In addition, previous studies summarized in Chapter 3 and past GHP curricula indicate that the cognitive content and teaching methods used in this investigation are appropriate for gifted high school mathematics students. Therefore, population validity did not seem to be violated.

Inadequate descriptions of instruments and procedures used in the investigation constitute a major threat to ecological validity (Huck et al., 1974, p. 262). The instruments for this study are described in Chapter 3; copies of these instruments can be found in Appendix B. A detailed account of the data collection process is given in Chapter 3, along with a description of the treatments. An outline of the computer programming course can be found in Appendix C.

Another threat to ecological validity is pretest and posttest sensitization. Before the subjects took the pretest, they knew that a course on computer programming would be offered to all who had not had such a course before. The mathematics GHP students seemed to assume that the pretests and posttests were part of the GHP program evaluation and not part of a specific experiment. Even though achievement testing for grades is not part of the GHP program, test-taking is not foreign to these students, and they responded favorably to the testing situation. Since the instruments were unobtrusive measures, these GHP subjects did not seem to be threatened. However, the posttest scores on the Test of Computer Ability (TCA) indicated that the subjects learned about programming from the computer programming courses (both treatment groups).

Because of the unique GHP environment, the fact that students lived on campus during the six-week experimental period, and the fact that the investigator instructed both treatment groups, the remaining possible threats to ecological validity do not apply to this investigation.

Replication

During the summers of 1980 and 1981, the investigator again taught four beginning computer programming courses at the Governor's Honors Program. Although a little more introductory direct group instruction was given, the teaching approach which was used was the directed independent study technique. The students were high-achieving gifted secondary students who had been chosen to participate in GHP by the same screening process as the subjects in 1979. The students in the computer courses (58 in 1980 and 57 in 1981) had little or no prior computer experience. The course content was essentially the same as that used in the 1979 study. Although the conditions were the same as in 1979, because of the nature of GHP, no formal data were gathered. Even though no tests were administered, a record of the number of programs completed was kept. The results were essentially the same as those of the 1979 study. Based on the student evaluations at the end of each summer, the students enjoyed the course and liked the teaching technique. Only one student each summer expressed a desire to have had more direct group instruction. Based on the records of the number of computer programs run, teacher observations, and student evaluations, the results obtained the two subsequent summers were similar to those of the summer of 1979.

In addition to the time-sharing system, three microcomputers were available for student use in the summer of 1981. Many of the students preferred using the microcomputers to the university time-sharing system.

Essentially, the same course content was taught during the 1979-80, 1980-81, 1981-82, and 1982-83 school years in a high school. The teaching method used was mainly the independent study approach with tests given periodically. The TCA was the first quarter final exam. Some direct group instruction was given on introductory material and as reviews for tests. The able students fared well under this approach, making good test grades and writing efficient programs. The less motivated students appeared to need more direct group instruction.

Summary

From the results of Hypotheses 1, 3, and 4, the students did not change in independence of judgment, view of computer science, or locus of control. According to Hypothesis 2, both treatment groups became better computer programmers; therefore, both treatment groups did profit from the course.

From the results of Hypotheses 5 and 6, it is not possible to predict the posttest scores on the Test of Computer Ability based on the view of computer science, locus of control, or independence of judgment.

Based on Hypothesis 7, there is an association between scores generated by the VMI and the number of computer programs run. Hypothesis 8 showed that there is a relationship between the number of computer programs run and the view of computer science for Treatment 2 only. From Hypothesis 9, there is a relationship between computer ability and the number of programs run.

Based on Hypotheses 10 and 11, a person's sex does not affect his or her ability to program a computer or attitudes toward computer science.

Since there were only 5 subjects out of 60 in the treatment groups who had used a programmable calculator, Research Question 5 could not be adequately assessed.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter presents conclusions related to each of the three problem statements declared in Chapter 1. Recommendations for further study and consideration conclude this chapter.

Based on the rationale which was presented in Chapter 1, the investigator examined the following three-part problem statement.

1. Can one design, implement, and evaluate two courses in computer programming, one with direct group instruction and one without direct group instruction, for gifted high school students?

2. Is it possible to predict which students will achieve more using group instruction and which will achieve more working independently?

3. Are there differences with regard to sex in ability to learn computer programming and attitudes toward computer science?

Conclusions

Problem Statement 1

Can one design, implement, and evaluate two courses in computer programming, one with direct group instruction and one without direct group instruction, for gifted high school students? The design of the course Beginning Computer Programming was pursued after reviewing the results of the pilot studies. The pilot studies and the available subjects both are discussed in Chapter 3. The computer course outline and the course handouts for the students with direct group instruction are contained in Appendix C. In Chapter 3 the investigator presented a description of the implementation of the two courses in computer programming, one without direct group instruction (T_1) and one with direct group instruction (T_2). In Chapter 4, the statistical results pertaining to the first four hypotheses and the discussion of Research Question 1 provided the basis for evaluating the two courses.

<u>Beginning Computer Programming</u>. Beginning Computer Programming was designed to instruct the students in computer programming in the BASIC programming language. It also illustrated how the computer can be used in learning mathematics. Based on the significant increases in scores from the pretest to the posttest on the Test of Computer Ability and the record of the number of programs run, these goals were accomplished for both treatment groups.

The course content included components of the computer, history of the computer, and programming in the BASIC language. The students in each treatment group wrote programs based on many mathematical concepts including functions, triangular condition, equation of a line, slope of a line, approximation of roots, the arithmetic of complex numbers, the quadratic formula, matrices, trigonometry, limits of sequences, partial sums, and area under a curve. Some students finished the assigned programs and worked on extra projects in areas of interest to them.

All three of the objectives in the course outline were met. The learners exhibited a knowledge of the BASIC computer programming language, demonstrated an ability to log on and off a computer terminal, and applied programming to other branches of mathematics. The posttest scores on the Test of Computer Ability and the number of programs run, as reported in Chapter 4, documented the accomplishment of these goals.

Instruments. The evaluation of the first problem statement revolved around four instruments which are described in Chapter 3: the Barron Test of Independence of Judgment (BIJ), the Test of Computer Ability (TCA), the View of Mathematics Inventory (VMI) as modified to be view of computer science, and the Internal-External Locus of Control (LOC). These four instruments can be found in Appendix B.

1. Barron's Test of Independence of Judgment. The lack of significant differences between the scores on the BIJ was perhaps due to the fact that this highly gifted population was already very set in their view of independence of judgment. On a scale of 0-22, 90 of 93 students were within 4 points between their pretest and posttest scores, 84 of 93 students were within 3 points, and 72 of 93

were within only 2 points. Only one student's scores differed by 6 points, and no set of scores differed by more than 6.

2. Test of Computer Ability. The increase in the scores from pretest to posttest on the TCA for the two treatment groups was dramatic. Several subjects' scores went from the lowest possible (0) to the highest possible (40); 36 of the 60 treatment group subjects' scores went from 5 or lower to 30 or greater.

3. View of Mathematics Inventory. Perhaps the reason that few students changed their view of computer science is that the students already had a very positive attitude toward mathematics in general and computer science in particular. This was supported by the high pretest and posttest scores on the VMI. Only 6 scores out of the 186 pretest and posttest scores for treatment and control groups were under 100, with the range of possible scores from 35 to 175.

4. Internal-External Locus of Control. The scores on this test could range from 0 through 23, with the higher the number, the more the person views his life as being controlled by external forces. The scores of the subjects were low, with only 8 of 186 scores over 12. This indicated that this population, on a whole, viewed their lives as being self-controlled. It was reasonable to assume that this overwhelming view of internal locus of control would be changed very little in a course of short duration.

Treatments. For each treatment group, there was a significant gain in computer ability from the pretest to the posttest. Therefore, both treatment groups learned computer programming, but the two treatment groups cannot be compared with each other to ascertain the better teaching method, since t tests were used to analyze the data (see discussion of Hypothesis 2 in Chapter 4). Since both treatments were successful, perhaps the possible side benefits of the method without direct group instruction, which were outlined in Chapter 1, would make the directed study method the more desirable teaching method.

Problem Statement 2

Is it possible to predict which students will achieve more using group instruction and which will achieve more working independently? In Chapter 4 the statistical results pertaining to Hypotheses 5 through 9 and the discussion of Research Questions 2 and 3 provided the basis for the discussion of this problem statement. Based on Hypotheses 5 and 6, it was not possible to predict the posttest score on the Test of Computer Ability based on the view of computer science, locus of control, or independence of judgment. Based on Hypotheses 7 and 8, the number of programs run could be predicted by the post-BIJ, the post-VMI, and the post-LOC for Treatment 2 by the following prediction equation:

$$\widehat{NPC} = .4948 \text{ Post-VMI} + .7757 \text{ Post-LOC} + .6831 \text{ Post-BIJ} - 53.16253$$

For Treatment 2, 58.7% of the score called NPC could be predicted by the post-VMI, the post-BIJ, and the post-LOC. But for Treatment 1, none of the scores from pre-VMI, post-VMI, pre-LOC, post-LOC, pre-BIJ, or post-BIJ predicted the number of programs run. Perhaps the students with direct group instruction who had little time in class to run programs needed extra motivation to come back at night and on weekends to run their programs. This could account for the relationship between the VMI and the NPC for Treatment 2.

The only additional instrument used to investigate Problem Statement 2 was the number of programs completed (NPC). Fifteen out of 60 students completed all 21 programs, 7 in T_1 and 8 in T_2. Forty-four students completed 10 or more programs, 20 in T_1 and 24 in T_2. There seems to be no difference in the two treatments as to the number of programs run.

Based on Hypothesis 9 there was a relationship between the number of programs run and both the pretest and posttest scores on the Test of Computer Ability for Treatment 1 and the posttest only for Treatment 2. The pretest scores on the TCA could be used to predict the number of programs run for Treatment 1, the group without direct group instruction.

In reviewing the correlation coefficients by treatment groups, it was found that there seems to be a relationship between the Test of Prerequisite Knowledge (TPK) and the Number of Programs Completed (NPC) for the treatment without direct group instruction ($\underline{r} = .5180$, $\underline{p} < .005$), which does not exist for the treatment with direct group instruction (r = -.1915, p > .1). There also seems to be a relationship between the post-TCA and the TPK for the treatment without direct group instruction, since the correlation was significant (r = .3319, p < .05); whereas, there was not a significant correlation between the post-TCA and the TPK for the treatment with direct group instruction (r = .1611, p > .1).

This seems to indicate that TPK is a good predictor of the number of programs run and the increase in computer ability for the students taught without direct group instruction. This group of students received no instruction in the mathematical concepts involved in the assigned programs; therefore, their prior knowledge of the concepts was of more benefit to them than to the other treatment group which received instruction in the concepts.

Although there seems to be no difference in the total number of programs run by each of the treatment groups, there does seem to be a difference in each treatment in the type of student who ran the most programs. Students who had the prerequisite background as measured by the TPK, treated without direct group instruction, tended to run more programs than those students who did not have the prerequisite background. For the students in the other treatment, with direct group instruction, there was no such pattern.

Problem Statement 3

Are there differences with regard to sex in ability to learn computer programming and attitudes toward computer science? The statistical results pertaining to Hypotheses 10 and 11 and the discussion of Research Question 4 which is contained in Chapter 4 provided the basis for the discussion of this problem statement. It was found that a person's sex is not a factor in his or her ability to learn computer programming and/or attitudes toward computer science. In discussing the lack of differences according to sex, it must be remembered that in this select population all of the students chose not only to attend the Governor's Honors Program in mathematics, but also chose to take the computer course. Therefore, the population already had a very positive attitude toward computer science and a high ability level in mathematics. These facts could help explain the lack of difference due to sex.

The Student Information Profile (SIP) was an instrument used to obtain possibly useful information about the students. Other than sex, another piece of information obtained from the SIP was whether or not the student had programmed a calculator. Hypothesis 12 was intended to investigate the relationship between the use of programmable calculators and the scores on the posttest of the Test of Computer Ability and/or the number of programs run. Unfortunately, only one student in Treatment 1 and four students in Treatment 2 had ever programmed a calculator. Therefore, this factor could not adequately be addressed.

Recommendations

A review of the major findings and conclusions of this study led the investigator to propose several recommendations for further study and consideration.

1. Since few of the subjects in the study had prior knowledge of programmable calculators, and the short amount of time available for the study prevented their prior training, the effect of the ability to program a calculator on the learning of computer programming is an area for further investigation.

2. This study involved the teaching of computer science to gifted, high-achieving secondary mathematics students. Based on investigator observations in four replications of the study in a high school, further studies should investigate direct group instruction or little direct group instruction with more hands-on experiences for students of different ability levels.

3. This study consisted of only eight class meetings of a little over an hour each. A study comparing the teaching of computer science using direct group instruction and using little direct group instruction for a longer period of time should be investigated to ascertain whether longer time periods would produce different results than were obtained from this study.

4. Sex differences in ability to learn computer programming and attitude toward computer science should be

investigated using a different population, one not consisting of students who choose mathematics as a major area of study and/or who excel in mathematics.

5. The overwhelming majority of the GHP students in this study were rising seniors, while only 18 of the 93 students were rising juniors. Therefore, the effect of grade level and age on the ability to learn computer programming and/or attitude toward computer science is an area for further investigation.

6. The students were asked their teaching preference, direct group or little group instruction, before the courses began. In Treatment 1 only seven students wanted lecture and in Treatment 2 only five students wanted lecture, so both groups had essentially the same preferences. But after the completion of the courses, 22 students in Treatment 1 preferred no lecture, and 19 in Treatment 2 preferred lecture. The students tended to prefer the method under which they had been taught. One area of possible further investigation is the effect of the method of instruction on the student's preference of teaching method.

7. If the direct group instruction teaching method is employed, the mathematical concepts used in the programs can be taught along with the programming. But if the independent study approach is employed, prerequisite knowledge used in the programs assigned should be determined before commencing the course.

8. The scores generated by the Internal-External Locus of Control in this study indicated that this population viewed life as being controlled by internal forces. Is this true of gifted? Could the LOC be used to help in the identification of gifted? Further research needs to be pursued.

In conclusion, the results of Chapter 4 have produced many unanswered questions and identified several areas in which more research could be pursued. The major findings of this study are the following.

1. The design of a beginning BASIC computer programming course in which the computer is used to study mathematical concepts and procedures was accomplished.

2. For this study's population, sex was not a factor in either the subjects' abilities to write and run computer programs or the subjects' attitudes toward computer science.

3. For gifted secondary school students, both the direct group instruction and the directed independent study approaches appear to be effective means of teaching computer programming, but the two teaching approaches cannot be compared with each other to ascertain the better method since *t* tests were used to analyze the data.

The interrelationship of mathematics and computing is a rich field for further study. "The combination--mathematics plus computer--is essential to make effective use of mathematics in our technological society" (Moursund, 1973, p. 603).

References

References

Allison, J. F. Polar coordinate and computer-linked plotters. _Mathematics Teacher_, 1977, _10_, 166-169.

Anastasi, A. Commentary on the precocity project. _Mathematical talent_. Baltimore: Johns Hopkins University Press, 1974.

Anastasi, A. _Psychological testing_. New York: Macmillan, 1976.

Anderson, R. E., Klassen, D. L., & Johnson, D. C. In defense of a comprehensive view of computer literacy--A reply to Luehrmann. _Mathematics Teacher_, 1981, _74_, 687-690.

Asch, S. E. _Social psychology_. New York: Prentice-Hall, 1952.

Astin, H. S. Sex differences in mathematical and scientific precocity. _Mathematical talent_. Baltimore: Johns Hopkins University Press, 1974.

Barbe, W. B. (Ed.). _Psychology and education of the gifted_. New York: Appleton-Century-Crofts, 1975.

Barron, F. Some personality correlates of independence of judgment. _Journal of Personality_, 1953, _21_, 289-297.

Barron, F. _Creativity and personal freedom_. Princeton, NJ: D. Van Nostrand, 1968.

Barron, F., Demant, W. C., Edwards, W., Lindman, H., Phillips, L. D., Olds, J., & Olds, M. New directions in psychology, Vol. 2. New York: Holt, Rinehart, & Winston, 1965.

Battista, M. T. Formal axiomatic systems and computer-generated theorems. Mathematics Teacher, 1982, 75, 215-220.

Bidwell, J. Polynomial prime producers: A computer problem for secondary students. Mathematics Teacher, 1975, 68, 108-111.

Board of Directors of the National Council of Teachers of Mathematics. Position statements: Computers in the classroom. Mathematics Teacher, 1978, 71, 468.

Braun, L. Help!!! What computer should I buy??? Mathematics Teacher, 1981, 74, 593-598.

Burton, G. M. Regardless of sex. Mathematics Teacher, 1979, 72, 261-270.

California State Board of Education. Mathematics framework for California Public Schools. California: Bureau of Publications, California State Department of Education, 1975.

Cline, S. Simulation: A teaching strategy for the gifted and talented. Gifted Child Quarterly, 1979, 23, 269-271.

Committee on Computer Education. Recommendations regarding computers in high school. Washington, DC: Conference Board of the Mathematical Sciences, 1972.

Committee on the Undergraduate Program in Mathematics. Recommendations on undergraduate mathematics courses involving computing. Palo Alto, CA: Stanford University, 1972.

Curley, W. Programming Pascal's Triangle. Mathematics Teacher, 1974, 67, 705-708.

Dahlke, R. M. Studying the individual in an individualized course in arithmetic at a community college: A report on four case studies. Mathematics Teacher, 1975, 68, 181-188.

Dalphin, J. F. Alternative curricula. Paper presented at the Annual Conference of the Association for Computing Machinery, 1979.

Damaskos, N. J. A case study in mathematics--The cone problem. Mathematics Teacher, 1969, 62, 642-649.

Donovan, H. The computer society. Time, February 20, 1978, pp. 44-59.

Dugdale, S. Green globs: A microcomputer application for graphing of equations. Mathematics Teacher, 1982, 75, 208-214.

Duncan, D. Teacher's commentary--Elements of calculus and analytic geometry. Menlo Park, CA: Addison-Wesley, 1967.

Duncan, D. A pattern: Pascal's triangle and prime numbers. Mathematics Teacher, 1975, 68, 23-28.

Durr, W. The gifted student. New York: Oxford University Press, 1964.

Emond, W. J. Some benefits of microcomputers in teaching statistics. Computer and Education, 1982, 6, 51-54.

Fennema, E. Teachers and sex bias in mathematics. Mathematics Teacher, 1980, 73, 169-173.

Fennema, E., & Behr, M. J. Individual differences and the learning of mathematics. Research in mathematics education. Reston, VA: National Council of Teachers of Mathematics, 1980.

Fey, J. T. Mathematics education research on curriculum and instruction. Research in mathematics education. Reston, VA: National Council of Teachers of Mathematics, 1980.

Flexer, R. J. Comparison of lecture and laboratory strategies in a mathematics course for prospective elementary teachers. Journal for Research in Mathematics Education, 1978, 9, 103-117.

Flynn, M. The computer's impact on mathematics: Numerical and the Monte Carlo method. Mathematics Teacher, 1974, 67, 458-460.

Folk, M. Should your school get a microcomputer? Mathematics Teacher, 1978, 71, 608-613.

Forsythe, A. Computer science: A first course. New York: John Wiley & Sons, 1969.

Fox, L. H. Sex differences in mathematical precocity: Bridging the gap. Intellectual talent research and development. Baltimore: Johns Hopkins Press, 1976.

Gallagher, J. J. Teaching the gifted child, 2nd ed. Boston: Allyn & Bacon, 1975.

George, W. C., Cohn, S. J., & Stanley, J. C. Educating the gifted acceleration and enrichment. Baltimore: Johns Hopkins University Press, 1979.

Georgia Department of Education. Special education regulations and procedures. Atlanta: Author, Office of Instructional Services, 1976.

Golden, N. Computer programming in the BASIC language, 2nd ed. New York: Harcourt-Brace-Jovanovich, 1981.

Gowan, J. C., & Demos, G. D. The education and guidance of the ablest. Springfield, IL: Charles C. Thomas Publishers, 1964.

Gowan, J. C., & Torrance, E. P. Educating the ablest. Itasca, IL: F. E. Peacock Publishers, 1971.

Graflund, R. Patterns and puzzles in modern math. Portland, ME: Weston Walch, 1970.

Hart, M. Using computers to understand mathematics. Mathematics Teaching, 1981, 80, 42-46. (a)

Hart, M. Using computers to understand mathematics: Four years on. Mathematics Teaching, 1981, 81, 52-54. (b)

Hatfield, L. L., & Kieren, T. E. Computer-assisted problem solving in school mathematics. Journal for Research in Mathematics Education, 1972, 3, 99-112.

Hay, L. Using the computer to help prove theorems. Mathematics Teacher, 1981, 74, 132-138.

House, P. A., Gullivan, M. L., & Knoblauch, S. F. On meeting the needs of the mathematically talented: A call to action. Mathematics Teacher, 1977, 70, 222-227.

Huck, S. W., Cormier, W. H., & Bounds, W. G., Jr. Reading statistics and research. New York: Harper & Row, 1974.

Johnson, D. C., Anderson, R. E., Hansen, T. P., & Klassen, D. L. Computer literacy--What is it? Mathematics Teacher, 1980, 73, 91-96.

Johnsonbaugh, R. Applications of calculators and computers to limits. Mathematics Teacher, 1976, 69, 60-65.

Katena, J. Some thoughts on the gifted child. Gifted Child Quarterly, 1977, 21.

Katzman, P. W. Computer assisted mathematics program--Geometry. Atlanta: Scott, Foresman, & Co., 1970.

Kennedy, J. B. Graphing polynomials with computer assistance. Mathematics Teacher, 1981, 74, 516-519.

Kerlinger, F. N. Foundations of behavioral research, 2nd ed. New York: Holt, Rinehart, & Winston, 1973.

Kieren, T. E. Computer assisted mathematics program--Intermediate mathematics. Atlanta: Scott, Foresman, & Co., 1969.

Kirk, S. Educating exceptional children. Boston: Houghton Mifflin, 1972.

Kulm, G. Research on mathematics attitude. Research in mathematics education. Reston, VA: National Council of Teachers of Mathematics, 1980.

LaFrenz, D. E. Computer assisted mathematics program--Algebra. Atlanta: Scott, Foresman, & Co., 1969.

Lucito, L. J. Independence-conformity behavior as a function of intellect: Bright and dull children. In J. J. Gallagher, Teaching gifted students. Boston: Allyn & Bacon, 1965.

Lucito, L. J. Lecture notes, unpublished. Atlanta: Georgia State University, 1977.

Luehrmann, A. Computer literacy: What it is. Why it's important. Electronic Learning, June, 1982, pp. 20-22.

Lund, C. Pascal's triangle and computer art. Mathematics Teacher, 1979, 72, 170-184.

McCaig, D. A., & Jansson, L. A school computer network. Mathematics Teacher, 1978, 71, 694-697.

McDonald, S. Individual instruction: Thoughts, pro and con. Mathematics Teacher, 1975, 68, 574-578.

McLeod, D. B., Carpenter, T. P., McCormack, R. L., & Skvarcius, R. Cognitive style and mathematics learning: The interaction of field independence and instructional treatment in numeration systems. Journal for Research in Mathematics Education, 1978, 9, 163-173.

Miller, R. L. Individualized instruction in mathematics: A review of research. Mathematics Teacher, 1976, 69, 345-351.

Milner, S. D. The effects of teaching computer programming on performance in mathematics (Doctoral dissertation, University of Pittsburgh, 1982). Dissertation Abstracts International, 1972, 33, 4183A.

Mosteller, F., & Tukey, J. W. Data analysis and regression. Reading, MA: Addison-Wesley, 1977.

Moursund, D. Selecting goals for introductory computer programming course. Mathematics Teacher, 1973, 66, 599-603.

National Science Foundation. Science and engineering for the 80's and beyond. Washington, DC: Author, 1980.

Norris, C. A. Book reviews. Computer and Education, 1982, 6, 392.

Norris, F. R. Computer-programming problems involving place value. Mathematics Teacher, 1974, 67, 256-260.

Osborne, U. Individualized mathematics--A simple approach. Mathematics Teacher, 1976, 69, 390-395.

Papert, S. Mindstorms. New York: Basic Books, 1980.

Papert, S. Computers and computer cultures. Creative Computing, 1981, 7, 82-92.

Phillips, R. J. An investigation of the microcomputer as a mathematics teaching aid. Computer and Education, 1982, 6, 45-50.

Ralston, A., & Shaw, M. Curriculum '78--Is computer science really that unmathematical? Communications of the ACM, 1980, 23, 67-70.

Reichardt, J. Cybernetic serendipity. New York: Fredrick A. Praeger, 1969.

Rice, B. Going for the gifted gold. Psychology Today, 1980, 13, 55-67.

Rotter, J. B., & Hochreich, D. J. Personality. Dallas, TX: Scott, Foresman, & Co., 1975.

Schoen, H. L. A plan to combine individualized instruction with the lecture method. Mathematics Teacher, 1974, 67, 647-651.

Sheils, M. And man created the chip. Newsweek, June 30, 1980, pp. 50-56.

Shilgalis, T. W. Geometric transformations on a microcomputer. Mathematics Teacher, 1982, 75, 16-19.

Sisk, D. A. Education of the gifted and talented: A national perspective. Journal for the Education of the Gifted, 1978, 1, 354-366.

Stanley, J. C. Identifying and nurturing the intellectually gifted. In J. L. French (Ed.), Educating the gifted acceleration and enrichment. New York: Holt, Rinehart, & Winston, 1950.

Stanley, J., Keating, D., & Fox, L. Mathematical talent: Discovery, description, and development. Baltimore: Johns Hopkins University Press, 1974.

Stenberg, W. Calculus--A computer oriented presentation. Tallahassee, FL: Florida State University Press, 1968.

Straley, H. W. A way to individualize instruction in first-year algebra. Mathematics Teacher, 1977, 70, 418-422.

Thomson, T. R. A study on the design and evaluation of an implementation model for acquiring competencies reflecting the spirit and uses of mathematics. Unpublished doctoral dissertation, Georgia State University, 1976.

Torrance, E. P., & Reynolds, C. R. Images of the future of gifted adolescents: Effects of alienation and specialized cerebral functioning. Gifted Child Quarterly, 1978, 22, 40-54.

Tuttle, F. B., Jr. Characteristics and identification of gifted and talented students. Washington, DC: National Education Association, 1980.

Wagner, W. J. Circles, polargraphs, and a computer--Some unexpected results. Mathematics Teacher, 1982, 75, 323-328.

Walther, J. W. Computer assisted mathematics program--Second course. Atlanta: Scott, Foresman, & Co., 1969.

Williams, J. Modern physics. New York: Holt, Rinehart, & Winston, 1972.

Willoughby, S. S. Individualization. Mathematics Teacher, 1976, 69, 338-344.

Winer, B. J. Statistical principles in experimental design, 2nd ed. New York: McGraw-Hill, 1971.

Zabinski, M. P., & Fine, B. A computer discovery approach for quadratic equations. Mathematics Teacher, 1979, 72, 690-694.

Appendices

Appendix A

State of Georgia Guidelines for Selection of

Participants for the Governor's

Honors Program

GHP Interviews

A. For scoring on nominee's applications:

21-25	Excellent prospect
16-20	Very good prospect
11-15	Good prospect but not outstanding
6-10	Good--but have reservations
0-5	Not a prospect

Write scores in appropriate blanks.
Sign summary sheet in space provided.

B. For scoring on interview:

41-50	Definitely in GHP
31-40	Highly recommended
21-30	Good prospect but not outstanding. Write your reasons for giving this score. (Please be specific in comments.)
11-20	Good student but have reservations about with respect to GHP. Be specific as to why you assigned this score.
0-10	Not a prospect. State clearly your personal reasons for giving the nominee this score.

C. Interview timing:

Maximum: 2 minutes to review material
Minimum: 10 minutes for interview
Maximum: 3 minutes to write your evaluation, score, sign evaluation sheet, and sum the score

D. Following each interview:

1. Remind nominee to return team number card to waiting room.
2. Write comments on interview sheet.
3. Score interview.
4. Sign interview sheet.
5. Sum the interview scores and write sum on summary sheet.

6. Total all scores on summary sheet.
7. Clip summary sheet on top of all materials.
8. Sign GHP office form; clip on back of materials.

E. Following all interviews, please put classroom back in order.

MOTTO: Always leave the campsite neater than you found it!

Name
Last First Middle

Mathematics Interview Sheet--GHP

Suggested Interview Questions	Specific Comments
1. What are you presently doing in math? (Follow up with specific questions.) Tell us about a typical day in your math class.	
2. Research or project? If so, what? Explain! Pursued from own interest? or provided?	
3. Has done outside reading? Books other than texts? Use library? Other sources? What did he learn?	
4. Evidences enthusiasm for math? If so, root cause? Enjoys math just because successful in it or what?	
5. Intrigued with nonstandard problems, puzzles, games?	
6. Hungering for intellectual stimulation?	
7. What turned him on about math? What particular topics enjoyed? Aware of computers? probability and statistics? logic? Any evidence of "mathiness"?	
8. Is aware of what mathematicians do?	
9. Sensitive to applied math? pure math? Oriented to social science? physical science? other?	
10. Future? College major? Vocation?	
11. Have you had a problem you couldn't solve? How long did they work on it? Did anyone help?	
12. What are three adjectives which you would use to describe mathematics?	

13. Only about 1/4 of those being interviewed will be selected to attend GHP. Why do you feel that you should be among those selected?

14. Has a rich situation and makes the most of it--or a poor situation and makes the best of it?

Interviewer

Mathematics: The following criteria will be used by the state selection committee in choosing GHP finalists.

Criteria	Evidence
1. The student has high aptitude and achievement in mathematics identified by: (1) achievement test scores within upper 10% (based on national norms--scores must be submitted on student's credentials), (2) classroom performance, and (3) PSAT score (if available).	student transcript teacher recommendation
2. The student exhibits high level of original thinking in learning new ideas, solving problems, or finding discrepancies.	teacher recommendation student statement student interview
3. The student exhibits high mental ability as evidenced by test scores and performance.	student transcript teacher recommendation
4. The student has studied a variety of courses in mathematics, including geometry.	student transcript
5. The student can work independently and has the self-discipline to organize and carry through with a minimum of supervision--not only in regularly assigned work but also in self-motivated study.	student interview student statement teacher recommendation
6. The student is interested in studying and learning--with specific interest in mathematics--and has fun in the process; is willing and able to pursue in-depth study over an extended period of time.	teacher recommendation student statement student interview
7. The student is not satisfied with minimum discussion or exploration but thinks ahead and is curious about what follows.	teacher recommendation student statement
8. The student gives evidence of high verbalization competence which facilitates his thinking, reading, and both oral and written communication.	teacher recommendation student statement student interview
9. The student gives indication of a definite desire to study mathematics at GHP and express a personal commitment to attend and contribute to the program.	teacher recommendation student statement student interview

Team #:
Interview time:

__________ Total Score Finalist   Alternate No.____________________

Mathematics Interview Information--GHP

__________________________________Name
Last First Middle

______Total score from student record
(0–25)
average

Mathematics Courses:

Algebra________________

Geometry________________

Other________________

Present Grade________________

Math Grade Average____________

Class rank_____Class size_____

Test information______________

______Student statement. Comments:
(0–25)
average

Teacher recommendation. Comments:

Scorer______________________

Scorer______________________

______Interview Score. Comments (if interviewee is not acceptable for GHP, explicitly state reasons):
(0–100)
total

____
Interviewer

____
Interviewer

Appendix B

Instruments Used in the Study

View of Mathematics Inventory, Revised (VMI)

Please rate the following statements regarding computers and computer scientists according to the following rating scale representing your degree of agreement or disagreement and circle your rating.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

1.	Computer science has very precise language.	1	2	3	4	5
2.	Computer scientists stand very high in popular prestige.	1	2	3	4	5
3.	A great deal of computer science can be learned by anyone of average intelligence.	1	2	3	4	5
4.	Problem solving in computer programming, as in mathematics, amounts to finding a rule or formula which fits the situation.	1	2	3	4	5
5.	Each person can better understand his environment by learning computer science.	1	2	3	4	5
6.	The development of computer science seldom occurs because of a conjecture.	1	2	3	4	5
7.	Computer scientists show little concern for the beauty in mathematics.	1	2	3	4	5
8.	Computer science must be applicable to reality in order to have a reason for being.	1	2	3	4	5
9.	It is possible to passively learn computer science.	1	2	3	4	5
10.	Computer science restricts one's thinking to the use of rules.	1	2	3	4	5

11.	Computer science is not an end in itself, it is important to society because of its service to mankind.	1	2	3	4	5
12.	I find computer science to be boring.	1	2	3	4	5
13.	One should study computer science that he will not use in his job or his daily life.	1	2	3	4	5
14.	It is possible to solve any problem which fits into the computer science framework.	1	2	3	4	5
15.	The method and spirit of computer science needs to be emphasized more in general education.	1	2	3	4	5
16.	A computer system is of little importance if it has no immediate application.	1	2	3	4	5
17.	The process of looking at specific examples produces very little benefits for computer science.	1	2	3	4	5
18.	A country's economic development depends on the importance it attaches to computer science.	1	2	3	4	5
19.	Memorization of rules and formulae is extremely important for success in solving problems in computer science.	1	2	3	4	5
20.	One needs to know computer science in order to obtain a desirable job.	1	2	3	4	5
21.	Adventure and excitement exist in a computer scientist's work.	1	2	3	4	5
22.	The only way to create or develop a computer program is by a deductive process.	1	2	3	4	5
23.	The laziness of a computer scientist manifests itself in his use of undefined terms.	1	2	3	4	5
24.	At best, a computer model gives an approximate representation of some portion of the physical world.	1	2	3	4	5

25.	One must use the correct rule or program when solving a problem on computers.	1	2	3	4	5
26.	Providing models of physical phenomena in the world is a basic goal in computer science.	1	2	3	4	5
27.	Given a particular mathematical system, its properties are the same on earth as they are on the moon and Mars.	1	2	3	4	5
28.	The mass media has given enough attention to computer science.	1	2	3	4	5
29.	People tend to segregate computer science from the rest of society.	1	2	3	4	5
30.	Winning the esteem of his colleagues holds little incentive value for computer scientist in his work.	1	2	3	4	5
31.	Most persons do not sufficiently appreciate the power of computers.	1	2	3	4	5
32.	A teacher of computer science should include a course on applications in their education.	1	2	3	4	5
33.	A teacher needs to have a supply of applications to use in his teaching.	1	2	3	4	5
34.	A computer scientist does not like to share his findings with others.	1	2	3	4	5
35.	To understand and appreciate what is happening in today's world a person needs to know how to program computers.	1	2	3	4	5

Barron's
Test of Independence of Judgment

Please circle either True (T) or False (F) for each of the following statements.

		True	False
1.	What the youth needs most is strict discipline, rugged determination, and the will to work and fight for family and country.	T	F
2.	Some of my friends think that my ideas are impractical, if not a bit wild.	T	F
3.	Kindness and generosity are the most important qualities for a wife to have.	T	F
4.	I have seen some things so sad that I almost felt like crying.	T	F
5.	I don't understand how many men in some European countries can be so demonstrative to one another.	T	F
6.	I must admit that I would find it hard to have as a close friend a person whose manners or appearance made him somewhat repulsive, no matter how brilliant or kind he might be.	T	F
7.	A person should not probe too deeply his own and other people's feelings, but take things as they are.	T	F
8.	I prefer team games to games in which one individual competes against another.	T	F
9.	I could cut my moorings--quit my home, my family, and my friends--without suffering great regrets.	T	F
10.	What this country needs most, more than laws and political programs, is a few courageous, tireless, devoted leaders in whom the people can put their faith.	T	F

11. I acquired a strong interest in intellectual and aesthetic matters from my mother. T F

12. Human nature being what it is, there will always be war and conflict. T F

13. I believe you should ignore other people's faults and make an effort to get along with almost everyone. T F

14. The best theory is the one that has the best practical applications. T F

15. I like to fool around with new ideas, even if they turn out later to be a total waste of time. T F

16. The unfinished and the imperfect often have greater appeal for me than the completed and polished. T F

17. I would rather have a few intense friendships than a great many friendly but casual relationships. T F

18. Perfect balance is the essence of all good composition. T F

19. Science should have as much to say about moral values as religion does. T F

20. The happy person tends always to be poised, courteous, outgoing, and emotionally controlled. T F

21. Young people sometimes get rebellious ideas, but as they grow up they ought to get over them and settle down. T F

22. It is easy for me to take orders and do what I am told. T F

Internal vs. External Locus of Control

Instructions

This is a questionnaire to find out the way in which certain important events in our society affect different people. Each item consists of a pair of alternatives lettered a or b. Please select the one statement of each pair (and only one) which you more strongly believe to be the case as far as you're concerned. Be sure to select the one you actually believe to be more true rather than the one you think you should choose or the one you would like to be true. This is a measure of personal belief: obviously, there are no right or wrong answers.

Please answer these items carefully but do not spend too much time on any one item. Be sure to find an answer for every choice! Find the number of the item on the answer sheet and black in the space under the letter a or b which you choose as the statement more true.

In some instances you may discover that you believe both statements or neither one. In such cases, be sure to select the one you more strongly believe to be the case as far as you're concerned. Also try to respond to each item independently when making your choice: do not be influenced by your previous choices.

Questions

1. a. Students get into trouble because their teachers punish them too much.
   b. The trouble with most students nowadays is that their teachers are too easy with them.

2. a. Many of the unhappy experiences while programming computers are partly due to bad luck.
   b. A student's unhappy experiences while programming a computer result from the mistakes they make.

3. a. One of the major reasons why we have students who are dissatisfied in school is because students and teachers don't take enough interest in discussing problems.
   b. There will always be misunderstandings in school, no matter how hard students and teachers try to prevent them.

4. a. In the long run, students get the respect they deserve in this world.
   b. Unfortunately, a student's worth often passes unrecognized no matter how hard he tries.

5. a. The idea that teachers are unfair to students is nonsense.
   b. Most students don't realize the extent to which their grades are influenced by accidental happenings.

6. a. Without the right breaks one cannot be a good computer programmer.
   b. Capable people who fail to become good programmers have not taken advantage of their opportunities.

7. a. No matter how hard you try some teachers just don't like you.
   b. Students who can't get teachers to like them don't understand how to get along with teachers.

8. a. Heredity plays a major role in determining one's success in school.
   b. It is one's educational experiences which determine their success in the classroom.

9. a. I have often found that what is going to happen in the classroom will happen.
   b. In the classroom trusting in fate has never turned out as well for me as making a decision to take a definite course of action.

10. a. In the case of the well prepared student, there is rarely, if ever, such a thing as an unfair test.
    b. Many times exam questions tend to be so unrelated to course work that studying is really useless.

11. a. Becoming a successful computer programmer is a matter of hard work, luck has little or nothing to do with it.
    b. Getting a good job as a computer programmer depends mainly on being in the right place at the right time.

12. a. The average student can have an influence in decisions for governing a school.
    b. Schools are run by the few people who are in power, and there is not much the individual student can do about it.

13. a. When I study, I am almost certain that I can learn the material.
    b. It is not always wise to study too far ahead because many test grades turn out to be a matter of good or bad fortune anyhow.

14. a. There are certain teachers who are just no good.
    b. There is some good in every teacher.

15. a. In my case learning what I want to has little or nothing to do with luck.
    b. Many times we might just as well decide what to learn by flipping a coin.

16. a. Who gets to be the boss often depends on who was lucky enough to be in the right place first.
    b. Getting people to do the right thing depends upon ability, luck has little or nothing to do with it.

17. a. As far as computers are concerned, most of us are the victims of forces we can neither understand, nor control.
    b. By taking an active part in learning to program a computer we control how it functions.

18. a. Most people don't realize the extent to which their lives are controlled by accidental happenings.
    b. There really is no such thing as "luck."

19. a. One should always be willing to admit mistakes to the teacher.
    b. It is usually best to cover up one's mistakes from the teacher.

20. a. It is hard to know whether or not a teacher really likes you.
    b. How many teachers like you depends upon how nice a person you are.

21. a. In the long run the bad things that happen to us while working on a computer are balanced by the good ones.
    b. Most misfortunes while working on a computer are the result of lack of ability, ignorance, laziness, or all three.

22. a. With enough effort and cooperation we can overcome poor teaching.
    b. It is difficult for students to have much control over the adequacy of teaching.

23. a. Sometimes I can't understand how teachers arrive at the grades they give.
    b. There is a direct connection between how hard I study and the grades I get.

24. a. A good teacher expects students to decide for themselves what they should do.
    b. A good teacher plans what every student should do.

25. a. Many times I feel that I have little influence over the things that happen to me in the classroom.
    b. It is impossible for me to believe that chance or luck plays an important role in my life in the classroom.

26. a. Some students are lonely because they don't try to be friendly.
    b. There's not much use in trying too hard to please teachers, if they like you, they like you.

27. a. There is too much emphasis on athletics in high school.
    b. Team sports are an excellent way to build character.

28. a. What I get out of a learning situation is my own doing.
    b. Sometimes I feel that I don't have enough control over the directions my education is taking.

29. a. Most of the time I can't understand why teachers behave the way they do.
    b. In the long run the students are responsible for bad learning environments in the entire school as well as in an individual classroom.

Test of Computer Ability

1.
```
10 READ N
20 PRINT N, N↑2, N↑3, N↑4
30 GO TO 10
40 DATA 2,3,4
50 END
```

Write the output.

2.
```
10 READ X
15 IF X<=5 THEN 10
20 IF X>16 THEN 10
25 PRINT X, "SATISFIES BOTH CONDITIONS"
30 GO TO 10
40 DATA 7,23,-11,14,19,2
45 END
```

Write the output.

3.
```
10 LET X=1
20 LET X=X/2
30 IF X<.125 THEN 60
40 PRINT X
50 GO TO 20
60 END
```

Write the output.

4.
```
10 FOR A=1 TO 5
20 FOR B=1 TO 2
30 PRINT A,B
40 NEXT A
50 NEXT B
60 END
```

Debug.

5.
```
10 PRINT "FUNCTION INVERSE"
20 READ A,B
30 PRINT "Y=";A;"X+";B,"Y=";1/A;"X-";B/A
40 GO TO 20
50 DATA 3,2,4,-7,3,-5
60 END
```

Write the output.

6.

```
 5 READ X1, Y1, X2, Y2
10 IF X1=X2 THEN 20
15 IF Y1=Y2 THEN 30
17 GO TO 40
20 PRINT X1;Y1;X2;Y2;"SLOPE UNDEFINED"
25 GO TO 5
30 PRINT X1;Y1;X2;Y2;"SAME POINT"
35 GO TO 5
40 LET M=(Y2-Y1)/(X2-X1)
45 PRINT X1;Y1;X2;Y2;"SLOPE IS";M
50 GO TO 5
55 DATA 7,8,8,10,4,5,4,11,5,4,11,4
60 END
```

Write the output.

7.

```
 1 PRINT "X          Y"
 5 FOR X=-5 TO 5 STEP 1
10 LET Y=X↑2+X-1
15 PRINT X,Y
20 NEXT X
25 END
```

a. What is the purpose of this program?

b. What should you do next to find a more exact answer?

Output

X	Y
-5	19
-4	11
-3	5
-2	1
-1	-1
0	-1
1	1
2	5
3	11
4	19
5	29

8.

```
10 READ B,H
20 IF H<2*B THEN 40
30 GO TO 10
40 PRINT B,H, "RECTANGLE FITS"
50 DATA 3,7,11.86,23.74,19.57,39.4392
```

Debug.

9.

```
10 PRINT "COMPLEX NUMBER CONJUGATE"
20 READ A,B
30 PRINT A;"+";B;"I",A;"+";-B;"I"
40 GO TO 20
50 DATA 3,2,4,-3,-6,8
60 END
```

a. Write the output.

b. What is the purpose of line 10?

10.
```
10 READ A,B,C,D
20 PRINT (A*C+B*D)/(C↑2+D↑2);"+";(B*C-A*D)/
    (C↑2+D↑2);"I"
30 GO TO 10
40 DATA 3,4,0,0,4,6,5,8,-6.4,3.5,10.8,-1.2
50 END
```

Debug.

11.
```
10 READ A,B,C,
20 IF B↑2-4*A*C<0 THEN 35
25 IF B↑2-4*A*C=0 THEN 45
30 PRINT A,B,C, "TWO REAL ROOTS"
33 GO TO 10
35 PRINT A,B,C, "NO REAL ROOT"
40 GO TO 10
45 PRINT A,B,C, "ONE DOUBLE ROOT"
50 GO TO 10
55 DATA 1,10,25,3,2,1,11,12,2
60 END
```

a. Write the output.

b. What is the purpose of the program?

12.
```
 5 LET T=2
15 FOR N=1 TO 3
25 PRINT N,T
35 LET T=T*2
45 NEXT N
55 END
```

a. Write the output.

b. What method is used?

13.
```
10 LET T=1
20 FOR N=1 TO 6
30 PRINT N,T
40 LET T=T+2
50 NEXT N
60 END
```

Write out the sequence generated by this program.

14.

```
10 LET T=1
20 FOR N=1 TO 10
30 PRINT N;"!=";T
40 LET T=T*(N+1)
50 NEXT N
60 END
```

Write the first three lines of output.

15.

```
10 FOR N=1 TO 1000
20 PRINT N,(3*N↑2+3)/(6*N↑2+1)
30 NEXT N
40 END
```

a. What is the purpose of this program?

b. What is the output getting closer and closer to?

Test of Prerequisite Knowledge

1. $f(x) = \frac{(x^2+1)^3}{(x-3)(2x+1)}$

   a. Find f(2)=__________

   b. Find f(3)=__________

2. a. Write out the formula for finding the slope of a line containing (x_1,y_1) and (x_2,y_2):________________

   b. Write the slope-intercept form of a line with slope m and y-intercept b:______________________________

3. P(3,4) and Q(-2,9)

   a. Find the slope of the line containing P and Q:______

   b. Find the equation of the line containing P and Q:____________________

4. Write the multiplicative inverse of the matrix:

$$\begin{pmatrix} 2 & 4 \\ 2 & 3 \end{pmatrix}$$

____

5. a. Write the quadratic formula:________________________

   b. Solve $2x^2+3x-1=0$ for x. ___________________________

6. What happens between x=3 and x=5 for a continuous function for which f(3)=-7 and f(5)=4? _________________

7. Perform the following operations for complex numbers:

   a. (3+4i)+(7-3i)= _______________________

   b. (2-7i)-(11+4i)= ______________________

c. $(3+i)(2-3i)=$ ____________________

d. $\frac{7+3i}{2+i} =$ ____________________

8. Find the following limits:

a. $\lim_{n\to\infty} \frac{5n-2}{6n+2} =$ ________________

b. $\lim_{n\to\infty} \frac{n^2+1}{3n-2} =$ ________________

c. $\lim_{n\to\infty} \frac{8n^2+7n+1}{n^3-3n} =$ ________________

9. Write the next term of the following arithmetic progression: 3, 10, ____

Write the next term for the following geometric progression: 2, 10, ____

10. $5!=$ ____________

Student Information Profile

Please give the following information:

Name______________________________ Birthdate____________________
(month, day, year)

Home Address________________________________ Age_______________
(years, months)

____
(city) (state) (zip code)

Size of city (check one):

___Rural area (under 2,500)

___Small city (2,500 to 50,000)

___Large city (50,000 and above)

Sex (check one):

___Male

___Female

Name of School:____

City:____

Size of School - 10th through 12th grade (check one):

Class	Size
AAAA	___800 and above
AAA	___525-799
AA	___300-524
A	___Up to 299

Class (check one)

___Rising Junior

___Rising Senior

Please circle Yes or No:

Have you ever been introduced to the following concepts?

Functions	Yes	No
Slope	Yes	No
Quadratic Formula	Yes	No
Complex Numbers	Yes	No

Matrices	Yes	No
Sequences	Yes	No
Arithmetic Progressions	Yes	No
Geometric Progressions	Yes	No
Limits	Yes	No
Factorial	Yes	No
Have you ever used a calculator?	Yes	No
Have you ever programmed a programmable calculator?	Yes	No
Have you ever written a program for a computer?	Yes	No
Have you ever run a program on a computer?	Yes	No
Do you have any experience with computers?	Yes	No

If you have computer experience, describe the experience:

Computer Assisted Mathematics Assigned Programs

______	40	#3
______	45	#3
______	59	#5
______	59	#7
______	67	#5
______	78	#1
______	91	#1
______	96	#4
______	124	#1
______	129	#1
______	157	#1D
______	157	#1Q
______	157	#2E
______	160	#4
______	174	Limit 2
______	176	#4
______	187	#2
______	191	#3A
______	191	#3B
______	191	#3C
______	192	#5

Sign Up Sheet

NAME	TIME IN	TIME OUT	MAJOR AREA

Student Preference Questionnaire

Name ____

Circle the number of your class:

1 2 3 4

Circle the teaching method under which you would prefer to be taught (A or B).

A. Little or no lecture with problems assigned from a textbook with a check-off list for computer programs which have been correctly run. The students progress at their own rate while the teacher answers questions on an individual basis. Class time is spent writing and running programs.

B. A lecture class in which the teacher lectures some each day to the class by going over the writing and debugging of programs similar to the programs that the student is asked to write. Less in-class time is available for running the programs because of the lecture provided.

Beginning Computer:

Please circle the class: 1 2 3 4

Class 1	A first class
Class 2	A second class
Class 3	B first class
Class 4	B second class

Please discuss all good and bad points about your computer class.

Appendix C

Computer Course Outline and Materials

Computer Course Outline

Beginning BASIC computer programming will be studied with an emphasis on how the computer can be used to learn mathematics.

I. Introduction

   A. Components of the computer
      1. Hardware
      2. Software

   B. History of the computer

II. BASIC Language

   A. Symbols

   B. Statements
      1. READ-DATA
      2. LET
      3. PRINT
      4. END

   C. Loops
      1. GO TO
      2. FOR-NEXT

III. Programs

   A. Functions

   B. Hopper function

   C. Triangular condition

   D. Equation of a line
      1. Slope
      2. Intercept
      3. Inverse

   E. Approximation of roots

   F. Complex numbers
      1. Sum
      2. Difference
      3. Product
      4. Quotient

G. Quadratic formula

H. Matrices

I. Trigonometry

J. Limits of sequences

K. Partial sums of series

L. Area under a curve

IV. Extra Projects

A. Pascal's triangle

B. Mean, median, and standard deviation

Topics are included in the course outline above.

Objectives

The learner will:

1. exhibit a knowledge of the BASIC computer programming statements;
2. demonstrate an ability to log on and off a computer terminal; and
3. apply programming to other branches of mathematics.

Activities

Activities include discussing the math involved in the programs and the commands used in the BASIC language. The students will then write and run programs. The students will progress at their own rate of speed with just enough class discussion to get them started on the programs.

The primary objective of the course is to show how the computer can be used as a tool in the learning of math. The secondary goal is to show how to program a computer.

Calendar

The students will progress at their own rate running the assigned programs using the teacher as a resource person, so there is no definite schedule of what program will be completed on what date.

Independent projects will be decided by the teacher and the student if time permits.

Evaluation Procedures

Evaluation of student progress can be made by the observation of the amount of extracurricular time spent in the computer room. Another measure is the quantity and quality of the programs written.

Class Meeting Days

Date	Classes Meeting
Thursday, June 21	Classes 1 and 2
Friday, June 22	Classes 3 and 4
Monday, June 25	Classes 1 and 2
Tuesday, June 26	Classes 3 and 4
Thursday, June 28	Classes 1 and 2
Friday, June 29	Classes 3 and 4
Monday, July 2	Class 1
Tuesday, July 3	Class 2
Thursday, July 5	Class 3
Friday, July 6	Class 4
Monday, July 9	Classes 1 and 2
Tuesday, July 10	Classes 3 and 4
Friday, July 13	Classes 1 and 2
Monday, July 16	Classes 3 and 4
Thursday, July 19	Classes 1 and 2
Saturday, July 21	Classes 3 and 4
Monday, July 23	Classes 1 and 2
Tuesday, July 24	Classes 3 and 4

Computer Course Handout 1

logon

power on button — Power 1st on, last off.
switch back
cursor to home — Wait for ▷ each time.

Transmit (T) red button

▷ ENTER USER ID/PASSWORD:

▷ GHMS/MATH (T)

▷ (a) CTS (T)

▷ > ▷ BASIC (T)

▷ > ▷ NEW (T) (or OLD)

▷ NEW PROGRAM NAME? ▷ (UP TO 12) (T)

(PROGRAM)

logoff

▷ > ▷ (a) FIN (T)

switch forward
power off

To print (a) (a) PRNT

To stop (a) (a) NOPR

Infinite loop MW ▷ (a) (a) X-TO

▷ > ▷ OLD (T)

▷ OLD PROGRAM NAME? ▷ MARTHA (T)

▷ > ▷ RUN

Computer Course Handout 2

Fill in the following from the overhead transparencies.

1. Computer uses -

2. History -

3. Five basic parts of a computer -

4. Hardware -

5. Types of computers -

6. Software -

7. Flowchart -

Computer Course Handout 3

Fill in the following from the overhead basic operations:

Statements

LET

END

PRINT

GOTO

READ

DATA

INPUT

Computer Course Handout 4

REM

IF THEN

FOR NEXT

RESTORE

FUNCTIONS

Computer Course Handout 5

	BASIC Notation
$a + b$	`A+B`
$a - b$	`A-B`
$a \times b,\ a \cdot b$	`A*B`
$a \div b$	`A/B`
a^4	`A↑4`
$a < b$	`A<B`
$a \leq b$	`A<=B`
$a \neq b$	`A<>B`
$\sqrt{a}$	`SQR(A)`
$[x]$	`INT(X)`
sin	`SIN(X)`
cos	`COS(X)`
tan	`TAN(X)`
$\lvert x \rvert$	`ABS(X)`
log	`LOG(X)`
random number	`RND(X)`
arctangent	`ATN(X)`
e^x	`EXP(X)`

Computer Course Handout 6

BASIC Commands

1. PRINT (direct quote or calculation)

   Every program must have a PRINT statement in order to obtain output.

   Two kinds of print: PRINT "direct quote"
   PRINT X or 2*X+3 (value of variable or calculation)

2. READ (variable or variables)
   READ X or READ X,Y

   We use a READ statement to assign to the listed variables values obtained from a DATA statement. Neither statement is used without one of the other type.

3. DATA (sequence of numbers)

   Only numbers and commas are used.

4. LET (variable) = formula

   LET X = 5 LET X = X + 1

5. GOTO (line number)

6. IF (condition) THEN (line number)

   There are times when we are interested in jumping the normal sequence of commands, if a certain relationship holds.

7. FOR (variable) = formula TO (formula) STEP (formula)

   ```
   FOR X = 0 TO 100 STEP 5

   NEXT X
   ```

   No crossed loops!

   ```
   FOR X = 5 TO 8
   FOR Y = 10 TO 20
   NEXT X
   NEXT Y
   ```

8. END

   Every program must have an END statement.

9. REM

   REM THIS PROGRAM FINDS . . .
   not printed in output

10. INPUT (variable or variables)

   Means for putting in DATA.

11. RESTORE

   Restores data so that it can be used again.

12. DIM

   Whenever we want to enter a list or a table, we use a DIM statement to inform the computer to save us sufficient room for the list or the table.

DIM M (35)	Can enter list of 35 items
DIM (5,7)	Table 5 x 7, 5 rows and 7 columns

Computer Course Handout 8

Exercises

Write and run the following programs:

1. A program using at least the following statements:

   LET, PRINT, END

2. A program using at least:

   READ, DATA, GOTO, END, PRINT

3. A program using at least:

   INPUT, REM, IF THEN, PRINT, END

4. A program using at least:

   FOR, NEXT, PRINT, END

Computer Course Handout 9

1. Write and run a program to determine if a number put in by means of an INPUT statement is odd or even. Establish a loop so that several numbers can be put in during one run of the program. Provide a means of stopping.

2. Write and run a program to find the sum of the smallest 10 odd integers.

3. Write and run a program to find Y if Y = 2*X-3 and X = -6, -2, 0, 1, 2, 4, 6.

   Have the output in the form: X =   and Y =

4. Write and run a program to find the area of a circle for any inputted radius.

5. Write and run a program to determine the value of the change you have.

Computer Course Handout 10

Write and run the following programs.

1. Given two points, find the slope, equation of the line, and equation of the inverse. Use the following for data:

(1,1) and (2,2)	(-1,6) and (5,8)
(3,5) and (5,3)	(4,-7.8) and (-3.1, -4.5)
(4,7) and (9,2)	(4.7, 5.9) and (-3.1, 94.6)
(2,3) and (2,5)	(4,7) and (8,7)

2. Given an equation in the form of A*X↑2 + B*X+C = 0, find all solutions.

A	B	C
0	0	5
-6	8	-3
0	0	0
0	3	4
-4	0	9
3.5	-12	0

3. Given two complex numbers, find the +, -, x, and ÷.

2 + 5i and 4 + 3i

25 - 74i and 36 + 452i

3 + 3i and 0 + 0i

4 + 6i and 1 + 0i

-8 + 1.414i and 32 + 8i

$\frac{54 + 4i}{2}$ and -78 - 8i

Computer Course Handout 11

Fill in the blanks:

```
  5  PRINT "A B C ROOT 1  ROOT 2"
 10  READ A,B,C
 15  IF B↑2-4*A*C<0 THEN ______________________________
 20  IF A=0 THEN 40
 25  PRINT A;B;C;(-B+SQR(B↑2-4*A*C))/(2*A);
 30  PRINT ______________________________________
 35  GO TO ______________________________________
 40  IF B=0 THEN 55
 45  PRINT A;B;C;_________________________________
 50  GO TO ______________________________________
 55  IF C=0 THEN _________________________________
 60  PRINT A;B;C;"NO SOLUTIONS"
 65  ____________________________________________
 70  PRINT A;B;C;"TRUE FOR ALL X"
 75  GO TO 10
 80  PRINT A;B;C;-B/(2*A)"+"SQR(4*A*C-B↑2)/(2*A)"I";
 85  PRINT ______________________________________
 90  GO TO ______________________________________
 95  DATA _______________________________________
100  END
```

Computer Course Handout 12

Complex Numbers: $i = \sqrt{-1}$

$\therefore i^2 = -1$

Sum: $(A+BI) + (C+DI) = (A+C) + (B+D)I$

Difference: $(A+BI) - (C+DI) =$ ____________________

Product: $(A+BI)(C+DI) = AC + BDI^2 + ADI + BCI = (AC-BD) + (AD+BC)I$

Quotient: $$\frac{A+BI}{C+DI} \cdot \frac{C-DI}{C-DI} = \frac{(AC+BD) + (BC-AD)I}{C^2+D^2}$$

What if $C^2+D^2 = 0$? ____________________

What is C-DI called in quotient? ____________________

For two points (X_1,Y_1) and (X_2,Y_2),

slope $m = \frac{Y_2 - Y_1}{X_2 - X_1}$ and equation of line $Y = mX + b$

What if $X_2 - X_1 = 0$? ____________________

What if $Y_2 - Y_1 = 0$? ____________________

What is b? ____________________

For $Y = mX + b$, the inverse is $X = mY + b$.

(interchange X and Y) or $Y =$ ____________________

Computer Course Handout 13

1. Write a program to find the roots of $f(X) = X^2 + X - 1 = 0$ to the nearest thousandth. Use -10 to 10 as the limits of the domain.

2. Write a program to find the solutions of a system of equations by using matrices. Input your data, and use several different sets.

Solve
$$\begin{aligned} X + Y - Z &= -1 \\ X \quad\; + Z &= 2 \\ -Y + Z &= 4 \end{aligned}$$
as one system.

MAT READ A (N, N) or MAT INPUT A (N, N)	data in mat. with dim N X N
MAT B = ZER (N, N)	zero mat. with dim N X N (all zero entries)
MAT B = INV (A)	inverse of mat. A
MAT PRINT X	prints mat. will be
$\begin{pmatrix} 7 & 5 \\ 1 & 3 \end{pmatrix}$	7 5 1 3

Computer Course Handout 14

```
 5  PRINT 'INPUT DOMAIN  LIMITS, STEP'
10  INPUT M, N, P
20  FOR X = M TO N STEP P
30  PRINT X, ____________________
40  NEXT X
50  GO TO 5
60  END
```

What is the purpose of this program?

What is a continuous function?

Why is it important for the rule in this program to be that of a continuous function?

Computer Course Handout 15

```
10   PRINT "ENTER # OF EQUATIONS IN SYSTEM"
20   INPUT N
30   PRINT "ENTER COEFFICIENTS OF SYSTEM"
40   MAT INPUT A (N, N)
50   PRINT "____________________________________"
60   MAT INPUT C (N, 1)
70   MAT B = ZER (N, N)
80   MAT B = ____________________
90   MAT X = ZER (N, 1)
100  MAT X = ____________________
110  PRINT "THE SOLUTION IS"
120  MAT PRINT X
125  GO TO ________________
130  ______________________
```

Complete and state the purpose of each line and the purpose of the program.

Computer Course Handout 16

A matrix is a rectangular array of numbers. The number of rows (across) and columns (down) are the dimensions of the matrix. To multiply matrices you multiply rows of the first by columns of the second.

$$\begin{pmatrix} -3 & 2 \\ 1 & 4 \end{pmatrix} \begin{pmatrix} -1 & 0 \\ 3 & 2 \end{pmatrix} = \begin{pmatrix} 3+6 & 0+4 \\ -1+12 & 0+8 \end{pmatrix} = \begin{pmatrix} 9 & 4 \\ 11 & 8 \end{pmatrix}$$

Matrices can be used to solve the system:

$$\left.\begin{matrix} 4X + 3Y = 19 \\ 7X + 9Y = 52 \end{matrix}\right\} \Rightarrow \begin{pmatrix} 4 & 3 \\ 7 & 9 \end{pmatrix} \begin{pmatrix} X \\ Y \end{pmatrix} = \begin{pmatrix} 19 \\ 52 \end{pmatrix}$$

Since $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} X \\ Y \end{pmatrix} = \begin{pmatrix} X \\ Y \end{pmatrix}$, we want

$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ in place of $\begin{pmatrix} 4 & 3 \\ 7 & 9 \end{pmatrix}$.

Since $\frac{1}{15} \begin{pmatrix} 9 & -3 \\ -7 & 4 \end{pmatrix} \begin{pmatrix} 4 & 3 \\ 7 & 9 \end{pmatrix} = \frac{1}{15} \begin{pmatrix} 15 & 0 \\ 0 & 15 \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

we multiply both members by $\frac{1}{15} \begin{pmatrix} 9 & -3 \\ -7 & 4 \end{pmatrix}$.

$$\begin{pmatrix} X \\ Y \end{pmatrix} = \frac{1}{15} \begin{pmatrix} 9 & -3 \\ -7 & 4 \end{pmatrix} \begin{pmatrix} 19 \\ 52 \end{pmatrix}$$

$$\begin{pmatrix} X \\ Y \end{pmatrix} = \frac{1}{15} \begin{pmatrix} 15 \\ 75 \end{pmatrix}$$

$$\begin{pmatrix} X \\ Y \end{pmatrix} = \begin{pmatrix} 1 \\ 5 \end{pmatrix}$$

X = 1 and Y = 5

In general, let A = NXN matrix
and B = NX1 matrix
and X = variable matrix

$AX = B$

$X = A^{-1}B$

Computer Course Handout 17

Factorials

1. $0!=1$ $1!=1$ $2!=1\cdot2=2$ $3!=1\cdot2\cdot3=6$ $4!=1\cdot2\cdot3\cdot4=24$

   $5!=1\cdot2\cdot3\cdot4\cdot5=120$

   $n!=1\cdot2\cdot3\cdot4\cdot5 \ldots n = n\cdot(n-1)\cdot(n-2)\cdot(n-3) \ldots 1$

   Write a program to find factorials. Find 1-10 factorials with the program.

---

2. A sequence is a function whose domain is the set of natural numbers. Write a program to find the first 100 terms of this sequence: $\left\{\frac{3n+5}{6n-2}\right\}$

   What is the output getting closer and closer to?

---

3. The nth partial sum of a series is the sum of the first n terms of the series.

   sequence $1, 1/4, 1/9, 1/16, \ldots$

   series $1 + 1/4 + 1/9 + 1/16 + \ldots$

   A series is the indicated sum of the terms of a sequence.

   Write a program to find the first 20 partial sums of $1 + 1/4 + 1/9 + 1/16 + \ldots$

   $S_1 = 1$

   $S_2 = 1 + 1/4$

   $S_3 = 1 + 1/4 + 1/9$

   $S_4 = 1 + 1/4 + 1/9 + 1/16$

   etc.

Computer Course Handout 18

Complete the following:

```
10  LET F = 1
20  PRINT "ENTER N"
30  INPUT N
40  IF N=0 THEN ________________
50  LET F = F*N
60  LET N=N-1
70  IF N>1 THEN ________________
80  PRINT F
90  END
```

Purpose: ____

Output for N=5 ______________________________________

```
10  LET T = 1
20  FOR N = 1 TO 10
30  PRINT N, T
40  LET T = T*(N+1)
50  NEXT ________________
60  ______________________
```

Purpose: ____

Output:

________ ________

________ ________

________ ________

________ ________

________ ________

What method is used in the calculation?

____

Computer Course Handout 19

```
10 FOR N = 1 TO 100
20 PRINT N, (2*N-4)/(6*N+2)
30 NEXT N
40 END
```

Purpose:____

What value will the output be getting closer and closer to?

```
10 LET S = 0
15 FOR N = 1 TO 20
20 LET T = 1/N↑3
25 LET S = S + T
30 PRINT N, T, S
40 NEXT N
50 END
```

Purpose:____

Output for the first five lines:

____

____

____

____

____

Computer Course Handout 20

1. Write and run the program on the card.
Important!!! Bring the printed out, run program to class with you next time.

A sequence $\{a_n\}$ is said to have a limit L if, for any $\varepsilon>0$, there is a natural number N_e such that $|a_n-L|<\varepsilon$ for all $n>N_e$.

(a) limit of your sequence in your program ____________

(b) $\lim\limits_{n\to\infty} \frac{2n+3}{4n-2} =$ ____________

(c) $\lim\limits_{n\to\infty} \frac{3n^2-4}{4n^3+1} =$ ____________

(d) $\lim\limits_{n\to\infty} \frac{n^3+1}{4n^4} =$ ____________

2. Run and print on the printer.

```
  5  PRINT "ENTER THE NUMBER OF LINES"
 10  INPUT N
 20  MAT A = ZER (N,N)
 30  FOR I = 1 TO N
 40  A (I,1) = A(I,I) = 1
 50  NEXT I
 60  FOR I = 1 TO N
 70  FOR J = 1 TO I
 80  IF J = 1 THEN 110
 90  IF J = I THEN 110
100  A (I,J) = A(I-1, J-1) + A(I-1,J)
110  NEXT J
120  NEXT I
130  FOR I = 1 TO N
140  FOR J = 1 TO I
150  PRINT A (I,J);
160  NEXT J
170  PRINT
180  NEXT I
190  END
```

Handout 20 (continued)

Purpose: ____

Output for N = 10: ____________________________________

3. Write a program of your own on back.