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AN INVESTIGATION OF CERTIFICATION IN COMPUTER SCIENCE AS A TEACHING FIELD IN SECONDARY SCHOOLS IN THE UNITED STATES

North Texas State University PH.D. 1983

AN INVESTIGATION OF CERTIFICATION IN COMPUTER SCIENCE AS A TEACHING FIELD IN SECONDARY SCHOOLS IN THE UNITED STATES

DISSERTATION

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

by

Harriet G. Taylor, M.A.
Denton, Texas
May, 1983

AN INVESTIGATION OF CERTIFICATION IN COMPUTER SCIENCE AS A TEACHING FIELD IN SECONDARY SCHOOLS IN THE UNITED STATES

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Taylor, Harriet G., An Investigation of Certification in Computer Science as a Teaching Field in Secondary Schools in the United States. Doctor of Philosophy (College Teaching), May, 1983, 201 pp., 16 tables, bibliography, 51 titles.

The purpose of this study was to investigate the status of computer science teacher certification in the United States. Methods used included a survey of chief teacher certification officers in all fifty states to determine the status of each state concerning the certification of high school computer science teachers and a survey of forty selected leaders in the field of computer science education to determine the current and future status of computer science education and to identify the courses most appropriate for computer science teacher training programs.

Status reports on all fifty states were presented. Summaries for the states that offer certification in computer science as a field by itself and as a part of another subject field were provided. Five state-approved computer science certification programs were reviewed.

Frequencies and percentages were reported for the data from the opinion poll. The five state-approved programs were compared to the program that was selected by the leaders in the field.

Findings were that computer science is a separate, distinct subject field in which high school teachers should be certified. A rapid downward movement of the college computer science curriculum into the high school was identified.

Lack of qualified teachers and programs to train these teachers were found to be major barriers to the introduction of computer science in the high school. A group of computer science courses most beneficial to high school teachers was identified and recommendations were made about the content of computer science teacher training programs.

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CHAPTER I

INTRODUCTION

During the last decade, computers have become a dominant force in American society. Indeed, there are few people in the United States whose lives are not in some way affected by a computer. Workers are being called on to use the computer as tools of their trades. David Moursund, one of the leading advocates of universal computer literacy, states that computers "are a fact of life in the adult world" (1977, p. 8). As a result of the introduction of the microcomputer in the 1970s, small personal computers have become common in many homes and schools in this country. The time has come for the American public to acknowledge that the computer era is here.

Accompanying the rise of the computer as a major factor in American life is the need for the educational system to recognize the computer's role in the lives of Americans and prepare students for life in such a society. This need has been growing since the late 1960s.

As early as 1970, the International Federation for Information Processing's Working Group on Secondary School Education investigated the role of the computer in society.

The group found that "the computer is already causing deep and rapidly accelerating changes in society and therefore the spectrum of jobs available" (IFIP, 1971, p. 21). Furthermore, they state that "It is important for all students to understand the nature and use of computers in a modern society" (IFIP, 1971, p. 1).

Over the past decade, many educators warned of the coming of the computer era and the mandate for computer education for the masses. Levien (1972) points out that as computer usage increases, so too must the extent of instruction about computers. Fu and Koo claim that "computers will play a dominant role in the lives of students" (1973, p. 51). Furthermore, many high schools will need to involve themselves in computer education since "the future clearly belongs to those who understand the computer" (Fu and Koo, 1973, p. 52).

As the 1970s drew to a close, educators were stating that basic computer awareness, or computer literacy, was essential for all students. Barnes states that "since computers are now playing an ever pervasive role in our society, it is imperative that every student learn about them, their capabilities, and their limitations" (1979, p. 37). Henderson claims that "it is important that every high school student have a general understanding of computers and computer applications" (1978, p. 41).

In his address delivered at the Second Annual Southern California Conference of Computer Using Educators, Edmund G. Brown, the governor of California, outlined his plan to promote computer education and the training of teachers in his state. His program was developed to meet the needs of students who will find "computer literacy critical to obtaining future employment in hundreds of fields" (Brown, 1982, p. 99). Governor Brown terms the proper use of computers in classrooms as a revolution in American education, second only to the move to provide free public education to all citizens.

Recently, many schools have begun to require basic computer literacy for high school graduation. Some educators predict that by 1990, computer literacy will be needed to function in our society and should be required of all high school graduates (Sjoerdsma, 1982). In a 1982 nationwide survey, 90 per cent of all adults polled felt that it was important for public schools to teach students how to use computers as part of their regular education ("Computer Education in Schools Wins Survey Approval," 1982).

During the last fifteen years, instructional uses of computers in secondary schools have increased dramatically. In 1966, 1.7 per cent of all public secondary schools used computers for instructional purposes (Mayer, 1978.). In 1972, the figure had risen to 12.9 per cent (Fu and Koo,

1973; Darby, Korotkin, and Romashko, 1972), and by 1975, it had risen to 27 per cent (Poirot, 1979). A 1982 study by the United States Department of Education shows that over half of the nation's secondary schools have at least one microcomputer or computer terminal for instructional uses by students (McCormack, 1982). Indeed, it would appear that in the not too distant future, most secondary schools will have the physical equipment needed to introduce computers into the curriculum.

High schools will be called on to provide basic computer education to students as well as specialized courses for those planning to pursue a data processing career or degree in college. The downward migration of the college computer curriculum which is referred to by Taylor (1980) has begun. Sjoerdsma predicts that by 1990 "most high schools will be teaching the first year of computing now taught by colleges and universities" (1982, p. 288).

The National Council of Teachers of Mathematics in its recommendations for school mathematics in the 1980s states that most students must not only become acquainted with the role of computers in society, but must also know how to use them (NCTM, 1980). The Council feels that schools must take an active part in preparing students to live in the computerized society in which they exist. Actions that should be taken include

> A computer literacy course, familiarizing the student with the role and impact of the computer, should be part of the general education of every student. . . . . .
>
> Secondary school computer courses should be designed to provide the necessary background for advanced work in computer science (NCTM, 1980, pp. 9-10).

Computer science is, therefore, evolving as a separate discipline in the secondary school. Since the development of the microcomputer, most schools can no longer point to cost as a deterrent to providing instruction about computers. The most frequently cited problems are the lack of teachers who are qualified to teach computer science courses as well as the lack of training courses to prepare computer science teachers. Cornwall proclaims that "the pool of college graduates entering the teaching field with a computer science background is nonexistent" (1982, p. 28).

Although many schools now offer computer science as a part of the high school curriculum, few teachers are certified to teach computer science. In most cases, the computer science teacher is a teacher who is certified to teach in another discipline, but who has a little experience with computers or perhaps was simply brave enough to take on such a class.

Beyond certification lies the problem of the lack of teacher training programs for those who desire to pursue computer science as a teaching field (Poirot, 1979). Milner (1975) claims that teacher education is a major barrier to

the introduction of computers in the classroom. Statz (1975) warns that universities and colleges of education should begin to train computer science educators, and that state departments of education should start certifying computer science teachers. Meinke (1976) predicts that there will be certification programs in many states in the not too distant future. Progress has been slow, however. In 1979, Moursund stated that "formal computer education programs of study, specifically designed for educators, are still rather few and far between" (1979, p. 56).

In 1980, the Taskgroup on Computer Science of the Association for Computing Machinery's Elementary and Secondary Schools Subcommittee addressed the issue of certification of computer science teachers. The taskgroup concludes that

> It is expected that in the near future, certification requirements for computer science teachers will be established throughout the educational system. Some schools and states have already established such requirements, and these should be met by all teachers where the requirement exist. However, until more teacher training programs are available in computer science at the secondary level, many teachers will find themselves teaching computing because of a personal interest, but with little or no formal training (ACM, 1980, p. 33).

Much has been written about the need for computer science education and the lack of certification requirements and training programs. Exactly where the United States now stands is conjecture.

This study may provide factual information on the current status of teacher certification in computer science in the United States. It may identify and analyze some existing state approved teacher training programs. It may report the opinions of national leaders in the field of computer science education about the importance of computer science certification and the composition of teacher training programs.

Through this study, the educational community may be able to see where it stands. The states that are preparing to institute state certification and begin teacher training programs will have access to guidelines. Using the information gathered by this study, educators all over the United States may be able to formulate plans to meet the growing demand, if not mandate, for computer education in the nation's secondary schools.

Statement of the Problem

The problem investigated by this study is the certification of secondary computer science teachers in the United States.

Purposes of the Study

The purposes of this study were

1. To determine the current status of certification in computer science in all fifty states;

2. To identify and analyze common characteristics of the computer science component of a state-approved program in each state that offers certification in computer science as a separate teaching field;

3. To ascertain if computer science is a separate discipline of sufficient importance to constitute an area of specialization in which teachers should be certified;

4. Through analysis of the existing programs and the opinions of the leaders, make recommendations about the computer science courses that are most useful for those who are training to be computer science teachers.

Research Questions

Following are the basic research questions that guided the course of this study.

1. Which states now offer certification in computer science as a separate area?

2. In those states that offer certification in computer science as a separate subject area, what are the requirements for certification, how many teachers are certified, and which one college or university in the state that now has a state-approved program that leads to computer science certification?

3. In those states that offer certification in computer science as a separate subject area, what are the computer science certification requirements for a teacher who is

already certified in a field other than computer science to be certified to teach computer science.

4. In those states offering certification in computer science as a separate subject area, what provisions were made so that those teachers already teaching computer science when the certification standards were adopted could be certified if they did not meet the requirements?

5. In each state that offers computer science as a separate certification field, what computer science courses are part of the curriculum in one state-approved program that leads to computer science certification?

6. What are the similarities and differences among the state-approved programs?

7. Is computer science a separate discipline distinct from any other subject area?

8. What are the opinions of leaders in the field of computer science education about the importance of certification of computer science teachers?

9. Which computer science courses do leaders in the field of computer science education feel should be part of a computer education curriculum that leads to certification in computer science?

10. Based on the analysis of the existing programs and opinions of the leaders in the field, what courses should be included as the computer science component of any teacher

training program that leads to certification as a teacher of computer science?

Limitations

This study is delimited to the review of the status of computer science as a certifiable subject field and identification of the computer science component of teacher training programs. Any sound teacher preparation program involves a well-conceived blend of courses and experiences that are designed to produce individuals who are not only professionally competent but who also have the general education needed to interact in the whole society. One component of such a program would be a sound background in an area of specialization, such as computer science.

This study considered only the computer science content of such a program. No attempt to define a total program or to evaluate any component of a program other than computer science content is made. Data collected by this study should be beneficial, however, to those responsible for the development of such a program. The task of the design of a complete, well based program in computer science education is left to the individual institutions and state agencies that must approve the programs.

Significance of the Study

Many educators now predict that in the near future computer science will be as fundamental to education as reading, writing, arithmetic (Kibler and Campbell, 1976). Soon every individual in this nation will need basic computer literacy just to function in the society (Molnar, 1978).

In addition, high schools will be expected to offer more specialized computer science courses to those preparing for computer-related employment and those pursuing technical degrees in colleges. Universities will expect incoming students to have acquired basic skills in computing in high school (National Council of Teachers of Mathematics, 1980).

The future clearly dictates a need for a supply of well-trained, qualified computer science teachers who can provide instruction on how to use computers as well as in basic computer literacy. Unless computer science is offered as a separate certification field and suitable training programs are developed, the prospective teacher will have to obtain certification and expertise in another subject field in order to be licensed to teach. Few individuals can afford the luxury of the extra time and money needed to become fully trained in computer science as well.

Many states perceive the need for standards for computer science teachers and are investigating the possibility

of such certification. One of the major hindrances is the lack of adequate information. Few precedents have been set. Most states do not offer separate certification in computer science, so there are very few training programs (Hector, 1980).

This study may identify the models that are in place as well as analyze their common characteristics. It will go beyond looking at the present and determine what computer science courses are most appropriate for a computer science teacher.

This study may investigate the central issues around the problem of certification of computer science teachers. Many states now consider computer science a math course that should be taught only by a teacher certified to teach math. In some states computer science is classified as a science or a business course.

Perhaps the most fundamental issue at hand is simply whether or not computer science is in reality a distinct discipline within itself. Furthermore, it should be determined if there is sufficient demand for computer science in the high school curriculum to substantiate the certification of teachers only in the discipline of computer science. If satisfactory solutions to both of these problems can be found, then the appropriate training for a computer science teacher must be ascertained. If there are courses other

than those found in the normal computer science bachelor's degree program that are fundamental to those who are preparing to teach, these courses must be developed.

Solutions to these problems have been sought over the past decade by many of the leading advocates of computer science education. Through compiling the available facts and opinions of those who can best answer these questions, this study will attempt to provide accurate, well-grounded answers to some of these issues which are fundamental to computer science education.

This study should provide accurate information about the current status of certification in computer science. With it, each state will be able to assess where it stands relative to other states. A true picture of our national situation and future directions should become clear. The study should provide information about programs that can be a valuable asset in the development of a state program.

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CHAPTER II

REVIEW OF RELATED LITERATURE

The modern electronic computer has become an established part of America life. Poirot reports that "it is difficult to find an individual in our country who is not directly or at least indirectly influenced by the electronic computer" (1976, p. 41). More recently, Heller and Martin (1982) claim that the average American comes in contact with a minimum of fifty computerized effects from the time he wakes up until he arrives at work. Souviney (1980) notes that the use and influence of computers is constantly growing, and, he predicts that by 1985 the average home in the United States is likely to have as many as twenty computer-controlled components or devices.

In the light of these facts and predictions, it is not surprising that Coburn and others (1982) feel that "computers appear to be revolutionizing every aspect of our lives" (1982, p. 1). As the use of computers becomes more widespread, so too will the need for an understanding, at least, by society of the ways that computers affect and can benefit it.

Accompanying this technological revolution must be an education revolution. An enlightened public is as essential

to the computer revolution as it was to other movements such as the revolution that changed our society from an agriculturally-based society to one that is based on industry.

Charp (1967) stresses that students must be enlightened, and not frightened by the changes occurring in our society. Furthermore, according to Charp,

> An understanding of the historical development of the computer is as much a part of a student's general education as an understanding of the development of other machines since the advent of the Industrial Revolution (Charp, 1967, p. 138).

For the United States to continue in the technological forefront, its citizenry must become educated in the new technology. Just as for the Industrial Revolution, workers will have to be trained to fill the new types of jobs created by the new technology (Charp, 1967). Public acceptance and confidence in the technology is essential. Just as in the Industrial Revolution, the vehicle to accomplish these goals is the educational system and the development of an educated citizenry.

An essential outcome, therefore, is universal computer literacy. Computer literacy implies that such literate individuals have the understandings, skills, and values needed to function in a computer-based society.

As early as 1968, Michael predicted the coming era in The Unprepared Society. Michael perceived a gap in society between those who work with and understand the uses and

effects of computers and the rest of the population. Michael echoes the sentiments of contemporary writers such as Kibler and Campbell (1976) with the prophecy that people who are ignorant of computers will be as functionally illiterate as those who are ignorant of reading, writing, and arithmetic. Finally, he reasons that to achieve true equity in society, all citizens needed an understanding of computers.

Indeed, sentiments such as Michael's are expressed frequently today. Many leaders feel that computers eventually will become a standardized tool for every classroom. The most basic goal is to insure that elementary and secondary school students acquire the basic rudiments of computer literacy.

One simple solution is to introduce the computer into the high school curriculum. Some schools are already requiring a basic course in computer literacy for high school graduation. Indeed, one of the main objectives of any educational system is to prepare students to function in society. If, as is predicted, computer literacy will soon be needed for a productive and useful life, then the educational system must respond to the challenge.

Such sentiments have been voiced by many of the leading advocates of computer education. In 1978, Henderson stressed the importance of a general understanding of computers

and computer applications for every high school student. Johnson and others (1980) report on the position of the National Council of Teachers of Mathematics regarding computers in the classroom. In its Agenda for Action, this group recommends the institution of not only computer literacy courses in high school but also the development of computer science courses that would be part of a high school computer science curriculum. Specifically, the council takes the position 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 and others, 1980, p. 92).

Another recommendation suggests that high school courses should be developed that go beyond computer literacy and explore the fundamental concepts of computer science. According to the National Council of Teachers of Mathematics,

> Secondary school computer science courses should be designed to provide the necessary background for advanced work in computer science. Curriculum design should provide the required foundation for those students who will be involved in careers that increasingly demand advanced computing skills and applications of computing and for those students who will go on to deeper study in frontier fields of computer development (NCTM, 1980, p. 10).

Predictions are that by 1990, the basic computer science courses taught in the first year by most colleges and universities will be taught in high school (Sjoerdsma, 1980; Mayer, 1979). Luerhmann also identifies this downward

migration of computing topics which are taught now in colleges and concludes that soon "college and university matriculants will arrive with a solid understanding of the fundamentals" (Luerhmann, 1980, p. 148).

Much, therefore, has been written about the need for implementation of computer-based courses, particularly in the high school, over the past fifteen years. Progress has come slowly, however. In a few states, computer science courses are part of the standard curriculum of most high schools. Still, there are no standardized courses, nor is there even agreement about where computer science fits into the curriculum.

A search of the literature reveals insights into many of the problems that are associated with the implementation of computer science courses in high schools and identifies factors that have inhibited such development. Some of these include reluctance and even opposition to change by both educators and the American public, the high cost of the computer hardware, the lack of adequately trained teachers, and the lack of curricula and a sound notion of where such courses would fit into the high school curriculum. The remainder of this synthesis will explore each of these factors.

Although change normally comes slowly in our educational system, it appears that educators are ready for

change. Most educators are now aware of the powerful influence the computer is exerting on our society, and they recognize the importance of incorporating computer science into the curriculum. The general public, as well, seems to favor mass computer education. In fact, in a recent survey, 90 per cent of all adults surveyed felt that computer education should be part of the general education of each student ("Computer Education in Schools Wins Survey Approval," 1982). Where there may have been reluctance in years past, this is no longer a real factor. Perhaps, then, the main barriers today are other factors.

In the early 1970s, few schools could afford to invest in computer hardware. Computers were very large, expensive machines that required excessive space and maintenance. Those schools that used computers leased terminals and bought or were given time on computers which were owned by large companies or state agencies. Even then, the cost was usually quite prohibitive.

The last few decades have brought rapid changes in the cost as well as size of computers. Kibler and Campbell (1976) point out that for a decade, the size and cost of computer hardware has been dropping by an order of magnitude every three to five years.

The development of the microcomputer, which is a small, economical computer about the size of a typewriter, in the

mid 1970s revolutionized the world of computing. Today small personal computers can be bought at local department stores for a tiny fraction of what a computer cost in 1970. Many of these computers are finding their way into schools and homes across the United States.

According to Lobello (1982), home computer sales in 1981 totalled 120 million dollars, and analysts predict a sales volume six times higher for 1982. Experts say that in the near future, computers will be found in most schools and homes in this country. As early as 1977, a microcomputer dealer, reporting on industry forecasts in Time, foresaw that "some day every home will have a computer. It will be as standard as a toilet" ("Plugging in Everyman," 1977, p. 39).

Educational institutions constitute a large portion of the home computer market. Correa (1979) estimates that 400 million dollars will be spent on microcomputer hardware by schools in 1982. Coburn and others (1982) found that there are already between a quarter and a half million microcomputers in schools.

According to McCormack (1982), a majority of the secondary schools in the United States now own at least one microcomputer or computer terminal for instructional purposes. Many high school students are, therefore, being exposed to computers at school. In 1970, one third of all

secondary students had used a computer (Jay, 1980). By 1980, well over half of all secondary students had used a computer (Jay, 1980; Wexler, 1979).

The development of the microcomputer has made available to the public low cost, affordable computing power. The cost of these devices is continually decreasing, so that cost of hardware soon will not be a major barrier to computer education. Lopez, confirming this analysis, says "microcomputer systems have lowered hardware costs so significantly that cost is no longer a serious factor against classroom use" (Lopez, 1981, p. 15).

The most frequently cited factor that inhibits the implementation of computer science education in secondary schools is the lack of adequately-trained teachers. Intwined with this factor are a number of major questions about the need for special training in order to teach computer science, about computer science as a separate field, or as part of another subject field such as math or science, about certification of teachers to teach only computer science, about the existence of programs designed to train computer science teachers, about the need for special programs designed only for computer science teachers, and about the elements of such a program.

Certainly, most educators believe that education is best served when it is conducted by personnel who are not

only trained in the methodology of teaching but also well-grounded in an area of specialization. Reasonably, therefore, computer science education should be directed by a person who has such training. Statz (1975a) identifies the lack of trained personnel as a major problem impeding the implementation of computer science courses in the secondary school. Statz further emphasizes that not only are trained teachers desirable but, perhaps, "without trained professionals, students gain a partial, perhaps incorrect, view of computers and their uses" (Statz, 1975a, p. 73).

In 1970, the Working Group on Secondary School Education (WG 3.1) of the International Federation for Information Processing (IFIP) investigated problems associated with the introduction of computers in the secondary schools. This group concluded that the major problem was teacher training. A product of this group's work is a booklet (IFIP, 1971) that describes what secondary school teachers of computer science should know.

During this period, the major theme was simply the need to find any teacher with enough training to conduct a basic computing class. Fu and Koo (1973) also identified the need for teachers with adequate training, but suggests (as did WG 3.1) that the solution is to train the math and science teachers in computer science and have them conduct computer science classes. Although trained teachers were needed,

computers were not so common in schools that a person could find full-time employment as a computer science teacher. The computer science teacher would have to be a teacher who was certified to teach in some other area of specialization (Moursund, 1975). Thus, in its beginning stages, computer science was generally introduced into the curriculum by a teacher trained in some other subject area, particularly math or science, or even business (Rogers and Austing, 1980; Poirot, 1976).

Since the mid 1970s, the computer has been introduced into secondary schools at a rapid rate (Poirot, 1976). By 1976, Statz (1976) claimed that enough full time jobs for computer science teachers were available so that teachers could be trained in computer science as the major field of specialization. In 1978, Henderson (1978) declared that every large school district needed personnel who were trained in computer science to teach computer science classes and coordinate computer uses in schools.

The trend has continued to the point that today there are many full-time job openings for computer science teachers. But the supply has not kept up with demand. As late as 1982, few teachers were receiving their primary training in the area of computer science. According to Cornwall, "the pool of college graduates entering the teaching field

with a computer science background is nonexistent" (1982, p. 28).

One major problem is to identify the group that should be trained to teach computer science. This problem involves deciding if computer science is mathematics, science, business, or an entirely separate subject area. Rogers and Austing (1980) found that computer science has generally begun in secondary schools through the mathematics program, and academic credit has usually been given as a unit of math. In other states, a computer science course may be counted as a unit of science, business, or even computer science. As of today, there is no national agreement on the true nature of computer science as a subject area.

Many leaders in the field of computer science education are beginning to classify computer science as a separate discipline. The Taskgroup on Computer Science of the Association for Computing Machinery's Elementary and Secondary Schools Subcommittee concludes that "computer science is a separate discipline and should be taught as such. It should be listed in curriculum guides and on transcripts under a title that makes it clear that the course is computer science" (Rogers and Austing, 1980, p. 16). Moursund (1975) predicts that eventually there will be standard computer science courses at the secondary level.

The possibility exists, then, that computer science is a discipline apart from any other subject area, and that teachers should, therefore, be trained in the discipline of computer science. Normally, as a prerequisite of employment, a teacher must be certified to teach in certain areas of specialization. The inference is that computer science might be a certifiable area of specialization. Since, certification usually depends on the completion of a state-approved teacher training program, there must be training programs specifically designed to develop teachers who will receive certification in computer science.

By 1975, two states, Wisconsin and Minnesota, were certifying computer science teachers (Statz, 1975a; Statz, 1975b). Meinke and Bauer (1976), reported in February, 1976, that still only Minnesota and Wisconsin offer certification in computer science. By October, 1976, according to Statz (1976), Ohio had joined Texas, Wisconsin, and Minnesota in offering such certification. Moursund (1977) confirmed in 1977, that as yet, only the same four states certified computer science teachers. In February, 1979, Poirot (1979) claimed that five states were offering computer science teacher certification. In June, 1979, Milner stressed that "the need to certify teachers of computer science is pervasive" (1979, p. 27), and he added that only four states in the United States offer computer science

certification. Thus, for the year 1979, reports conflict on the exact number of states that had adopted certification standards for computer science teachers.

When this study was begun, the most recent count of the states that certify computer science teachers was published by Hector in 1980. Hector wrote to the departments of education in all fifty states asking for certification requirements in computer science. Hector's 1980 findings are that only two states, Texas and Wisconsin, offer certification in computer science, but that approximately twenty others have some form of certification that is associated with another subject area. At that time, computer science was not identified as a certifiable subject area by Minnesota and Ohio.

Previous to this study, the exact number of states that certified teachers of computer science was not known and the latest reports gave conflicting data. No report lists many states offering computer science certification. Therefore, in most states a computer science teacher needed a specialization field other than computer science in order to be licensed to teach.

Certainly, adoption of certification standards would have to precede the development of state-approved teacher training programs. Given the low incidence of states that presently certify computer science teachers, it is not

surprising that there are few existing programs which are designed to train computer science teachers. Moursund points out that "formal computer education programs of study, specifically designed for educators, are still rather few and far between" (1979, p. 56).

Development of teacher education programs would include decisions about how much training is necessary for a computer science teachers, what specific competencies are needed by the high school teacher of computing, and what group of courses should be chosen to achieve these goals. Some possible answers to these questions could be derived from an examination of the literature devoted to the subject of teacher education in computer science.

Statz (1975a) argues that for the teacher who simply wants to use computers in the classroom, one or two computing courses might be a sufficient background. A much stronger background is needed, however, by high school teachers who teach computer science. Atchison (1973) reasons that the minimum background for a teacher of computing in secondary schools is a minor in computer science.

The most promising approach to the problem is taken by Poirot, Taylor and Powell (1981). First, they develop a set of computing competencies for all teachers and the more specific competencies that are needed by the teacher of

computing. Second, they present a group of topics of study that could be used to achieve these competencies.

Another program approach is to describe the content of such a program and include a group of courses that meet the content requirements. Statz (1975a) describes the general content of a teacher training program that includes a group of required courses, two required specialized education courses, and a recommended group of computer science electives. Frederick (1975) and Poirot (1975) also describe the characteristics of programs for potential computer science teachers and provide a list of courses that meet the criteria. Statz (1976) lists the courses that are part of the Ohio certification standards. These include a group of required computer science courses and a number of hours of computer science electives; the specific courses from which electives could be chosen are not listed.

Others have published descriptions of programs that had been implemented in their respective institutions. Statz (1975b) outlines the teacher training program at Bowling Green State University. This program, which, according to Statz, involves a solid background in computer science and education in the materials and methods of teaching computer science, was one of the three such programs in the United States at the bachelor's level in 1975 (Statz, 1975b).

Meinke and Bauer (1976) outline a master's degree program at the Illinois Institute of Technology. The program is designed to provide computer science training for teachers who were certified in other fields, and who had three or more years of teaching experience. It includes a required group of computer science courses, one of which is a practicuum in teaching computer science, and then two elective groups.

Poirot (1979) describes the teacher training program at North Texas State University. The program contains the required courses that are needed to develop competencies which are most important to a high school computing teacher. According to Poirot, the basic competencies are the ability to write programs in several high level languages, an overall understanding of the basic operation and organization of a computer, and the ability to teach computing courses.

There is general agreement on the computer science content for each of the aforementioned programs cited. The typical program involves a required group of six courses, that includes an introductory course covering algorithm design and principles of programming using a high-level language, assembly language programming, survey of data structures, survey of programming languages, fundamentals of computer organization, and uses of computers in education. Other courses that are mentioned, but not universally, as

required are social implications of computing and a second programming course using another high level language.

All agree on the importance of including a course in the material and methods of teaching computer science in such a curriculum, but in most cases this course is identified as a specialized course to be offered by the education department. Several programs describe specific elective groups, but there is no great degree of similarity among the identified groups.

The literature also presents many possible models for the computer science component of a computer education program. In most cases, it is assumed that the candidate will also complete all of the general education courses as well as the professional education courses required by the institution offering the program.

The literature includes many ideas on the nature of computer science as a separate, certifiable teaching field and on the appropriate training for the teacher of computing. Computer science is a dynamic, rapidly changing field. Several courses that are standard in most computer science departments today did not even exist in 1975. As new technological advances are made, the curriculum must adjust to meet the new technology.

Those who are developing computer science programs today will need to look at the existing programs and study

the opinions of the experts for guidelines. Research in the field must continue at a high level. It is only through research that the educators of the future will be able to identify the basic elements of computer science and to adjust the training programs to meet the needs of a changing society.

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CHAPTER III

PROCEDURES FOR THE COLLECTION AND ANALYSIS OF DATA

The Population

The population for this study consists of three groups:

1. The state teacher certification officer in each state or an appropriate state official as chosen by the state officer;

2. The institutions of higher education in the United States that offer state-approved programs leading to certification in computer science;

3. Nationally recognized leaders in the field of computer science education.

Selection of the Sample

Each state certification officer was asked to participate in the study. The certification officers were asked to respond to the questionnaire or forward it to an appropriate official for completion.

In each state that offers computer science certification, the officer responding to the questionnaire was asked to supply the name of one college or university in

that state which has a state-approved program leading to certification in computer science. In each state that offers computer science certification, only the institution listed on the state officer's questionnaire was contacted.

A group of forty leaders in the field of computer science education was chosen. Fifteen were chosen from the participants in EdCom '82, a national computer conference for educators. The participants in this conference were selected because of their recognition as leaders in their fields of expertise, based on publication and achievement in their respective areas of interest. In particular, the six panel members that spoke on "Keeping One Step Ahead: Teacher Training" were part of the sample. The participants in this conference are recognized as experts in the field and are well qualified to address the issues in question.

In addition, fifteen other leading computer science educators were selected who did not participate in EdCom '82, but who have distinguished themselves through publications and participation in at least one of the National Education Computer Conferences. Five other nationally recognized leaders were chosen on the basis of contributions during the last decade as evidenced by their publications in the area of computer science education. Finally, five active high school computer science teachers were included in the sample.

Data Collection

The data for this study were collected from a survey of certification officers of each state, and from documents supplied by the certification officers concerning state computer science certification requirements. In addition, descriptive brochures were collected from the selected institutions of higher education that have a state-approved computer science certification program. Finally, data was obtained from a national survey of leaders in the field of computer science education.

Status reports for the fifty states concerning computer science certification were developed from the questionnaires sent to the certification officers and brochures describing the state's certification requirements. Descriptions of state-approved programs leading to computer science certification were compiled using brochures and catalogs from the institution, as well as course descriptions, if needed, from the various departments within the institution, and through further written and telephone communications, if necessary.

A national opinion survey was conducted of leaders in the field of computer science education. These individuals were asked to state their opinions on the importance of certification in computer science and to list the computer science courses that should be included in a computer

science education curriculum. The survey was in the form of a self-administered questionnaire.

Research Design

A questionnaire (see Appendix D) was sent to the certification officer in each state. The respondents were asked to identify the state's current position on certification of computer science teachers. Prior to the distribution of the questionnaire, the content of the questionnaire was validated by a panel of five people. Included in this group were three administrators in the field of higher education and certification specialists in the college of education at two universities.

Those states that certify computer science teachers as a discipline by itself were asked to supply descriptive information about certification requirements, to identify one state-approved program leading to computer science certification, and to report on the number of certified computer science teachers in the state. Those states that certify computer science teachers as part of another subject area were asked to supply a description of the requirements in the other area, and any particular requirements for computer science teachers. States not certifying computer science teachers were not asked for further information.

The questionnaire was mailed with an accompanying pre-addressed envelope for the convenience of the respondents. A cover letter (Appendix B) soliciting the cooperation of the respondents also included an offer to send a complimentary summary of the completed research report. Because of the national nature of the study, it was hoped that 100 per cent of the sample would respond.

Follow-up solicitations by letter (Appendix C) were conducted three weeks after the initial mailing. Three weeks after the follow up letter was sent, phone calls were made to the certification officer of each state that had failed to respond. If the information could not be obtained through these solicitations, the college of education at a major university within the state was to be contacted and asked to participate. This procedure was unnecessary, however. Forty states responded to the first solicitation, and the other ten responded within a week and a half of the date of the follow-up letter. Therefore, all of the data were collected from the first two mailings.

One state-approved program was identified in each state that certifies computer science teachers, and letters were sent to each institution cited. The college or department of education within the institution was asked to furnish the curricular requirements for a degree leading to computer science certification. Course descriptions of the computer

science courses in the curriculum were obtained from the institution's general catalog, and further clarification was requested and received from the computer science department, if needed. Any other information needed to adequately identify the curriculum was solicited through correspondence or telephone conversations.

The college or department of education of each institution was contacted by phone and curricular information was requested. Phone requests for course descriptions also were made to the computer science departments. If the institution's catalog was not available through local library facilities, a catalog was requested.

Follow-up procedures consisting of a solicitation letter after three weeks of non-response and a phone call after three further weeks were used. Again, it was hoped that 100 per cent of the sample would respond.

A survey form (see Appendix G) was sent to each of the selected leaders in the field of computer science education. A cover letter (Appendix E) stressing the importance of the study and the value of the individual's participation was included along with a request for participation. A stamped, pre-addressed envelope was enclosed along with a guarantee of confidentiality.

A survey instrument was designed based on a synthesis of the relevant literature and interviews with experts in the field. Prior to its distribution, the instrument was tested for content validity by a panel of experts in the field.

In the first section of the instrument, respondents were asked to evaluate a series of items concerning the importance of certification of computer science teachers and the development of training programs designed especially for computer science teachers. A five point Likert-type scale was used throughout this section. An additional open-ended question solicited individual comments.

The next section of the survey instrument was designed to identify the computer science courses that should be included in a computer education curriculum. Respondents were given a list of twenty-four possible computer science courses, from which to choose a maximum of twelve courses.

The chosen courses were labeled with either an E or an R to indicate that the course should be part of an elective (E) group or a required (R) course. No more than six courses could be designated as required. The respondents had the option of writing in courses other than those listed on the form. No more than a total of twelve courses could be selected, although less than twelve could have been selected. The individual items in this section were chosen by

an examination of the literature describing existing programs or proposing content for such programs (Poirot, 1979b; Meinke and Bauer, 1976; Poirot, 1976; Frederick, 1975; Poirot and Early, 1975; and Statz, 1975b), and writings describing competencies needed by computer science teachers (Taylor, Poirot, and Powell, 1980a; Taylor, Poirot, and Powell, 1980b; Poirot and others, 1979a).

One major group of courses included are those in "Curriculum '78" (Austing and others, 1979), the basic curriculum defined by the ACM Curriculum Committee on Computer Science. Since most computer science departments are experiencing rapid growth in terms of the number of undergraduate and graduate computer science majors. These departments are hard pressed to provide the courses needed to meet the demands of their own curricula. It was unrealistic to expect many computer science departments to be able to add an entirely new set of courses that are primarily for teachers. Therefore, many of the courses to be taken by those who are training to be teachers will have to be selected from the standard computer science curriculum.

A final section of the survey instrument was designed to determine the high-level languages in which a computer science teacher should be proficient. Since most computer science departments offer programming courses in several

high-level languages, a major decision in the design of a teacher training program would be whether to allow students to specialize in the languages of their choice or to require specific languages. If, in the future, high school computer science courses become standardized, perhaps so should the basic languages for teachers. Respondents, therefore, were given a list of the major high-level languages and asked to pick a maximum of three languages in which teachers should be proficient. Again, a respondent could add in any language not on the list which he felt would be appropriate.

Once designed, the instrument was field tested for content validity and distributed to the leaders in the field. Follow-up solicitations, first by letter and then by phone were conducted. Efforts to solicit responses continued until a minimum of thirty responses (75 per cent of the sample) were completed and returned. The return envelopes were coded to allow for verifying the responses and determining the panelists to whom follow-up letters should be sent.

The overall research design calls for the collection of data that would lead to a description of each state's current status on the question of certification of computer science teachers. Descriptive data about existing programs were collected. Evaluation of the similarities and differences of the individual components of the programs is

made, but no ranking or evaluation of the individual programs was performed.

A five-point Likert scale was used on the first part of the questionnaire that was sent to the leaders in the field of computer science education. This scale lended itself to tabulation of responses to each question and a description of the relative significance attached to each issue by the panel.

Recommendations are made about the content of the computer science component of a computer education curriculum. The courses offered in each of the existing programs are categorized using course descriptions on the instrument sent to the leaders in the field, so comparisons can be made. In making these recommendations, more significance was attached to the opinions of the leaders in the field than the content of the existing programs.

Reporting of Data

Data collected from the state certification officers are reported in a common format, listing each state and describing its current position on the certification of computer science teachers. The data collected on the certification requirements of each state that certifies computer science teachers are summarized. The states that certify computer science as a discipline by itself are summarized

separately from those that consider computer science to be a related part of another discipline.

Summary reports describing each existing state program have been developed. Composite totals resulting from the classification of courses and the tabulation of frequencies are displayed in summary tables.

Reports of the data gathered from the national opinion survey are displayed in summary charts of the opinions on teacher certification and teacher training and a composite description of the courses chosen for a computer science curriculum was developed. Responses to the open-ended question are summarized separately.

Treatment of the Data

Responses to the individual items on the first part of the survey instrument were summed and then the mean computed to derive a numeric indicator of the level of agreement with each item. Conclusions drawn from this procedure are presented in narrative form.

Three frequency distributions of the courses selected in the second part of the instrument were constructed. The first indicates the number of times each item was chosen as a required course. The second shows how many times a course was selected to be part of an elective group. The final tabulation displays the number of times an item was selected for either group. A sample program has been designed using

the six courses selected most frequently as required courses and then from the remaining courses, the six courses most frequently selected for either group.

Similar distributions were made for the computer science courses that were part of the existing programs that were identified by states that certify computer science teachers. A summary is presented describing areas of agreement and nonagreement between these groups and the group selected by the survey instrument.

Frequencies were tabulated for each language listed in the third section of the instrument. Conclusions are drawn in summary form. Recommendations about the computer science content of a teacher training program and the true nature of computer science as an area of specialization were developed by the researcher through analysis of the opinions and preferences of the participants in the study.

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CHAPTER IV

REPORT ON THE SURVEY OF STATE CERTIFICATION OFFICERS

The purpose of this chapter is to report and analyze the data collected from a survey of the chief certification officer of each state. The survey form, which is included in Appendix D, was sent to the chief certification officer in each state. Each officer was asked to choose the one out of three categories that best described his state's position on computer science certification. In addition, those states signifying certification of computer science teachers as a separate subject area or as part of another subject area were asked to provide descriptive information about their state's requirements.

Within three weeks of the initial mailing, forty of the fifty state officers had responded to the survey. At that time, follow-up letters were sent to the remaining ten state officers. Within two more weeks, the ten remaining responses had been returned.

When this study was begun, it was felt that it was essential for all fifty states to participate to derive a true picture of the national status of computer science

certification. The goal of 100 per cent response was met quickly due to the prompt action of the state officers.

The Directory of 1981-1982 of the National Association of State Directors of Teacher Education and Certification provided the names and addresses of the state officers to whom the survey was sent. From the responses to the section of the form that asked for an individual to contact for clarification, it was found that several state certification officers had changed since the publication of the directory as well as the location of the offices. An updated list of the names, addresses, and phone numbers of these officers, reflecting those changes gathered through this study, is provided in Appendix A of this study.

The data collected by this survey are reported and analyzed in several sections. The first section is a status report on each state regarding computer science teacher certification. The other sections include notes about the states that do not certify computer science teachers apart from another discipline, summaries about the states offering separate computer science certification, conflicts between the data and the literature, and analysis of the data.

Status of Each State Concerning Computer Science Teacher Certification

The data in Table I indicate the status of each state concerning the certification of high school computer science

teachers as described by the chief certification officers. The three status choices in Table I correspond to the three choices on the survey form. The states are listed in alphabetical order in Table I.

Summaries are provided in the following section for those states that offer certification in computer science apart from any other subject area. The summaries are based on the narrative responses included on the survey form by the certification officers, information found in the descriptive brochures provided by the respondents, and insights gained through phone calls that were made to clarify the data.

Thirteen state certification officers responded that computer science certification is considered to be part of certification in another subject area in their state. They each were requested to supply additional information on the survey form about their state's regulations. Phone calls were made for the clarification of data in eleven of these thirteen states. Summaries for all thirteen states, including the information provided on the survey form and insights gained through the subsequent phone calls, are found in Appendix H.

Certification officers in eight of the states that have no provisions for the certification of computer science teachers voluntarily submitted extra information. Notes

TABLE I

STATUS OF EACH STATE ON CERTIFICATION
OF HIGH SCHOOL COMPUTER
SCIENCE TEACHERS

State	Status		
	(a) Offers separate computer science certification	(b) Offers computer science certification as part of another subject area	(c) No provisions for computer science certification
Alabama			X
Alaska			X
Arizona	X		
Arkansas			X
California		X*	
Colorado			X*
Connecticut			X
Delaware			X*
Florida		X*	
Georgia			X
Hawaii			X
Idaho			X
Illinois	X		
Indiana			X
Iowa			X
Kansas		X*	
Kentucky		X*	
Louisiana			X*
Maine			X
Maryland			X
Massachusetts		X*	
Michigan			X
Minnesota			X
Mississippi			X
Missouri			X*

TABLE I--Continued

State	Status		
	(a) Offers separate computer science certification	(b) Offers computer science certification as part of another subject area	(c) No provisions for computer science certification
Montana			X
Nebraska			X
Nevada			X
New Hampshire			X
New Jersey			X*
New Mexico			X
New York			X
North Carolina			X*
North Dakota		X*	
Ohio	X (special case*)	X*	
Oklahoma		X*	
Oregon			X*
Pennsylvania		X*	
Rhode Island		X*	
South Carolina			X
South Dakota		X*	
Tennessee			X
Texas	X		
Utah		X*	
Vermont			X
Virginia		X*	
Washington			X*
West Virginia			X
Wisconsin	X		
Wyoming			X

* See Appendix H for notes on this state.

that describe the additional information for these eight states are also included in Appendix H. It is possible that similar situations exist in other states, but such information is not available from the data collected as part of this study.

States That Offer Separate Computer Science Teacher Certification

The state certification officers in Arizona, Illinois, Texas, and Wisconsin responded that their states offer teacher certification in computer science apart from any other discipline. On the survey form, each officer who gave this response was asked to supply narrative responses to each of the following items.

a. Please supply the name of one college or university in your state that now offers a state-approved program leading to certification in computer science, which is representative of all the programs in your state.

b. Approximately how many certified computer science teachers are there in your state?

c. When computer science certification requirements were adopted, what provisions were made to certify those teachers who were already teaching computer science but did not meet the requirements for certification?

d. How can a teacher already certified in your state in an area of specialization other than computer science become certified in computer science as well?

e. Would you please either describe the requirements for computer science certification or enclose a brochure giving this information?

The following sections contain summaries of the responses to the five items by each state officer. In addition, any further insights gained from follow-up phone calls to all four state officers are included in the summaries.

Although no state standards for computer science certification have been adopted in Ohio, special permission has been granted to offer certification to graduates of one state-approved program in Ohio. This exceptional provision for the state of Ohio is also summarized.

Arizona

Computer science certification standards have only recently, within the last few months of 1982, been adopted in the state of Arizona. Computer science may now be posted as a major on a secondary (grades seven through twelve) certificate in Arizona. Thirty semester hours in computer science are required for a teaching major.

Currently, there are no state-approved teaching training programs in Arizona that offer a teaching major in

computer science. With the recent adoption of certification standards, it is predicted that the various teacher training institutions within the state will add such programs to their curricula.

A teacher who seeks initial certification can receive Arizona certification with a computer science major by completing thirty semester hours of computer science plus the normal professional and general education courses taken by secondary education majors. A teacher who is certified in another area may also become certified in computer science through the completion of thirty semester hours of computer science coursework.

Those certified teachers who desire to be approved for accreditation purposes to teach computer science can complete the requirements for a minor teaching area. Such a program usually includes eighteen to twenty hours of coursework, with the exact number of hours set by the accrediting association. Minor teaching areas in Arizona are not posted on certificates. Teachers who pursue this avenue would not be certified in computer science but would, in the eyes of the state, be qualified to teach computer science. The University of Arizona now offers a program in secondary education with a teaching minor in computer science.

Certification requirements, as well as the teaching of computer science as such, in Arizona are very new. The

exact number of certified computer science teachers in Arizona was not available, but was estimated to be very few. Decisions are still being made about provisions for those teachers who presently teach computer science. For actual certification, rather than only approval to continue to teach computer science, these teachers would still need to complete the required thirty hours of computer science coursework.

Illinois

Teachers who are completing a state-approved teacher training program with a teaching major in computer science may be certified in the area of computer science in Illinois. Thirty-two semester hours of computer science coursework are required for a teaching major. The only state-approved program in the state is offered by the Illinois Institute of Technology.

The number of certified computer science teachers in Illinois was not available. When computer science certification standards were adopted, those teachers who were presently teaching computer science, and who possesed a high school certificate with a mathematics or business major and five semester hours in computer science, were eligible for certification. Certified teachers who do not meet this requirement can be certified in computer science by completing thirty-two semester hours in computer science and a

computer science teaching methods course. In addition, they would need 100 hours of clinical experience in computer science.

Since the number of institutions that offer state-approved programs in Illinois is so limited, state officials reported that it is possible to be certified in computer science through transcript evaluation. An individual who completes thirty-two semester hours of computer science coursework along with the appropriate general and professional education courses, can be certified in computer science without being in a state-approved program. Officials believe that no one has been certified in computer science as yet through this procedure.

Ohio Exception

There are no state standards for computer science certification in the Ohio state blue book of certification standards. However, in several isolated areas, individual institutions which have been judged by the state to be capable of offering special programs to students, have been given state approval for such programs and permission to validate certificates in these areas. This is the case at Bowling Green State University in Ohio.

Several years ago, Bowling Green State presented the state with a plan for its computer science education program. The program was approved by the state and Bowling

Green was given the individual privilege of offering certification to its graduates in the area of computer science. This exemplary program is discussed in Chapter V, which is devoted to the review of state-approved programs.

In summary, the state of Ohio has no state computer science certification standards. Computer science certification can be achieved in Ohio, however, through completion of the program at Bowling Green State University.

Texas

Four universities in the state of Texas, Baylor University, East Texas State University, North Texas State University, and the University of Texas at Dallas, now offer state-approved computer science certification programs. The computer science coursework required by the state for these programs and for certification consists of twenty-four hours of computer science courses or mathematics courses in computer information science. At least twelve of the twenty-four hours must be in advanced courses.

Teachers who seek initial certification can be certified in computer science by completing one of the state-approved programs, with the recommendation of the institution. Teachers who have certification in an area of specialization other than computer science may add computer science as a teaching field by completing the twenty-four hour computer science component of one of the state-approved

programs and by receiving the institution's recommendation for the addition of a teaching field.

No information was available about the number of certified computer science teachers in the state of Texas. According to the Texas Education Code, those teachers who have been teaching a given subject prior to the development of certification standards are safeguarded in that assignment without having to meet the new certification requirements. The basic intent of this rule is to insure school accreditation. Such teachers are allowed by the state to continue to teach computer science, without specific certification in computer science, and pose no threat to the employing school's accreditation status.

Although Texas has adopted standards for certification in computer science as a teaching field, it has not yet included computer science on the list of approved courses that can be taught in the state's public schools. Generally, computing courses are classified as either mathematics, business, or vocational education, and such courses are taught by individuals with appropriate subject area credentials. According to state officials, teachers who are certified in computer science and have at least twenty-four hours of credit in mathematics, but not necessarily as part of a math education certification program, could be allowed through transcript evaluation to teach a course classified

as computer mathematics. A course entitled computer science may be taught only as an experimental course in secondary schools in the state of Texas.

Wisconsin

Computer science certification is available in Wisconsin to individuals who complete state-approved programs with a teaching major or minor in computer science. Thirty-four semester hours of computer science are required for a teaching major and twenty-two hours for a minor. Twelve of the thirty-one teacher training institutions in Wisconsin offer a teaching minor in computer science. The program at the University of Wisconsin at Green Bay is considered representative of all the programs in the state.

The total number of certified computer science teachers in Wisconsin was not available. One hundred seventy-one licenses were issued in 1981-1982. Most of these were issued through Wisconsin's liberal grandparenting clause which is still in effect. Certification is available through this clause to all who have had at least one year of experience teaching computer science. Teachers who are certified in other areas may obtain computer science certification either by meeting the grandparenting provisions or completing a twenty-two semester hour teaching minor in computer science.

Conflicts With the Literature

As noted in Chapter II, published reports since 1975 have conflicted regarding the number of states that offer computer science certification. Statz (1975a, 1975b) reported that only two states, Wisconsin and Minnesota, were certifying computer science teachers in 1975. Meinke and Bauer (1976) confirmed in 1976 that this was still the case.

In October, 1976, Statz (1976) in an article entitled "Another State Certifies Computer Science," says that as of June 14, 1976, Ohio has offered certification in a major and minor field of computer science. Statz (1976) also stated that Minnesota, Wisconsin, and Texas also were offering computer science certification at that time. In 1977, Moursund named the same four states as those that offer certification in computer science. Two 1979 reports differ, however, on the number of states. Poirot (1979) claimed that five states had adopted computer science certification standards, and Milner (1979) reported that only four states had such standards. Neither Poirot not Milner identify the states that were being counted.

The last report found on this matter was published by Hector in 1980. Hector surveyed each state and concluded that only two states, Texas and Wisconsin, offered computer science certification. Neither Minnesota nor Ohio was identified by Hector as a state in which such standards had been

adopted. Thus, Hector's finding directly conflicts with the earlier reports about the number of states that certify computer science teachers and the status of Minnesota and Ohio in particular.

According to the data collected by this study, neither Minnesota nor Ohio have adopted computer science certification standards. In addition, Arizona and Illinois have been identified as states in which such certification is now possible. Follow-up phone calls to clarify each state's position were made to all four states.

Officials in Minnesota insist that no such standards have been adopted in that state. No way was found to account for the earlier published reports to the contrary.

Ohio is an unusual case. No state standards have been adopted, but a special exception has been granted in the case of graduates of the program at Bowling Green State University. Thus, Ohio's exact status depends upon the individual's interpretation of the situation. In all probability, this unusual set of circumstances in Ohio has led to the conflicting reports.

Certification standards in Arizona have been established only within the last few months of 1982, certainly after the publication of all of the previously identified reports. Thus, Arizona is a valid new addition to the list.

Provisions have been established in Illinois for quite some time to grant certification in any area that was an approved subject in the Illinois public schools through completion of a thirty-two hour coursework major. However, only within the last few years has computer science been such a course and the one state-approved program instituted. Therefore, Illinois was rightfully omitted from earlier reports, but should now be included in any such list.

Analysis of the Data Collected by the Survey of State Certification Officers

According to the data collected by this study, only four states, Arizona, Illinois, Texas, and Wisconsin, have adopted standards for the certification of teachers in the area of computer science. Ohio, in one special case, could issue a license in computer science, but statewide standards have not been developed in Ohio.

Although adoption of computer science standards by the various states appears to be progressing very slowly, the evidence does show that computer science is moving into the high schools and that many states have at least developed regulations pertaining to the instruction of such courses. Today, many states have identified and approved the academic computer science courses that can be taught in public schools and have classified them under various subject areas. They also have developed special accreditation

guidelines for determining who is allowed to teach these courses. California, Pennsylvania, and South Dakota appear to be the leaders in this movement.

Several of the certification officers interviewed during the follow-up phone calls feel that given the relatively small number of teachers who have actually completed enough computer science coursework to meet any potential certification standards, that development of some measures of quality control for school accreditation purposes is the most appropriate goal for their state at this time. Doubt was expressed that individuals with a substantial number of hours in computer science, even if certified, would actually pursue teaching as a career. It was thought that such individuals would probably seek more lucrative positions in industry or serve as consultants to the local school districts. Their efforts are better spent, they believe, in identifying those teachers who have some computer science training and adopting regulations whereby they could be assigned to teach computing classes.

It would appear that little progress has been made in terms of the number of states that offer computer science certification. The most substantial apparent result is an increased awareness of the growing demand for computer science in the secondary schools and the responsibility of the

states to insure the quality of the preparation of teachers assigned to conduct such courses.

At present, few states now offer a broad range of academic computer science subjects in high school. If predictions come true about the downward migration of the college computer science curriculum into the high school, more high schools may establish computer science departments and more states may move toward the adoption of state computer science certification standards.

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CHAPTER V

REVIEW OF SELECTED STATE-APPROVED COMPUTER SCIENCE EDUCATION PROGRAMS

Certification officers in each state in which computer science teacher certification standards have been adopted were asked to identify one state-approved computer science teacher training program in their state that is representative of all the programs in the state. The universities named were the University of Arizona, the Illinois Institute of Technology, North Texas State University, and the University of Wisconsin at Green Bay. In addition, although Ohio has not adopted state computer science certification standards, it has granted approval for certification of graduates of the state-approved program at Bowling Green State University.

The purpose of this chapter is to review the programs at the five universities cited. The following sections contain brief narrative descriptions of each program that emphasize the computer science coursework component. The programs are listed alphabetically by state. Sources of information for the descriptions include the catalogs and brochures provided by the institutions and telephone

conversations with appropriate representatives of each institution.

The University of Arizona

The University of Arizona offers a Bachelor of Science in Secondary Education with a teaching minor in computer science. Students who are enrolled in this program also choose a teaching major from a list of approved major fields offered at the university. Computer science is available only as a minor teaching field at the University of Arizona. Presently, no college or university in the state of Arizona offers a state-approved program that includes a teaching major in computer science.

Arizona certifies teachers only in major subject fields. Certified teachers who complete twenty semester hours of coursework in a teaching field other than their major field may be assigned by schools to teach in the field in which the additional coursework was done. Such a teacher is approved but not certified in the additional field.

Therefore, graduates of the program at the University of Arizona that includes the eighteen-hour teaching minor in computer science are not eligible for computer science certification but could possibly be approved to teach computer science. Since there are no state-approved programs in Arizona that offer a teaching major in computer science, individuals who desire computer science certification in

Arizona could be granted such credentials through transcript evaluation after completion of thirty semester hours of computer science coursework. Presumably, then, any graduate of the program at the University of Arizona who has the additional coursework could be certified by the state in the field of computer science.

Recently, changes have been made in the computer science course sequence that is required for a teaching minor at the University of Arizona. These changes will be reflected in the 1983-1985 catalog. The courses identified in this summary are those in the new course sequence instead of the courses outlined in the 1981-1983 catalog.

A computer science teaching minor at the University of Arizona consists of eighteen semester hours of computer science, which includes five required courses and one elective. The elective must be a 400-level course, which are reserved for advanced undergraduate courses.

The five required courses are course 115, Computer Science Principles, course 227, Program Design and Development, course 237, Introduction to Assembly Language Programming, course 327, Comparative Programming Languages, and course 342, Data Structures. The catalog descriptions of these courses are included in the Appendix.

The first two courses, 115 and 227, are beginning and advanced courses in problem analysis, algorithm design, and

program development using a high-level language. The titles of the remaining three required courses accurately describe course content.

The courses that comprise the teaching minor at the University of Arizona are determined by the computer science department. Students who are enrolled in the program are supervised, however, by the secondary education department. All of the minor courses are part of the normal computer science course sequence that is taken by computer science majors. The emphasis of the courses selected is on the development of sound computer scientists.

Noticeably absent from this program are courses that concentrate on the educational aspects of computer science. The College of Education at the University of Arizona now offers two experimental courses, an introductory course on microcomputers in education and a more advanced course on microcomputer applications, that emphasizes areas such as computer-assisted instruction, design of computer-based materials, and curriculum design. These courses could be elected by the secondary education major who is minoring in computer science. If the program is expanded to include a major in computer science, some of the additional coursework may be courses such as these that bridge both fields.

Illinois Institute of Technology

The Illinois Institute of Technology offers the only state-approved computer education program in the state of Illinois. In past years, the two available programs were an undergraduate program with a teaching minor in computer science, and a master's program specifically for certified teachers. The undergraduate program has recently been discontinued. The master's program is discussed in this summary.

The Master of Science for Teachers, or MST degree in computer science, was developed in 1970 (Bauer and Meinke, 1975). The program "evolved as a result of computer science emerging as a separate discipline at the secondary school level" (Meinke and Bauer, 1976, p. 35). The purpose of the program is not to teach an individual how to teach per se, but to strengthen an experienced teacher's academic background in computer science as well as the teaching of computer science.

Applicants must have a bachelor's degree and at least a B average on the entire undergraduate program or appropriate evidence attesting to the individual's ability. In addition, the program is open only to certified teachers who have a minimum of three years of successful teaching experience.

Three computer science courses, or their equivalent, are required prerequisites for the MST program. These courses include CS 460, Fundamentals of Computers for Teachers (an introduction to programs and languages), CS 461, Practicuum in the Teaching of Computer Science (which deals with the practical experience of teaching computer science in secondary schools), and CS 350, on computer systems and organization (which includes assembly language programming).

About thirty people have completed the program. Those who are currently enrolled are part-time students who hold teaching positions. An average of three and a half years of part-time study is needed to complete the program. Under standards recently adopted by the state of Illinois, MST graduates are eligible for computer science certification through transcript evaluation.

The MST program is a state-approved program of thirty-two hours of coursework which is divided into three components. The program includes a core component of fifteen semester hours, a twelve-hour elective program, and a five-hour project.

The core component requires CS 440, Programming Languages and Translators I, CS 485, Computers and Society, CS 560, Computer Science in the Classroom, CS 561, The Computer and Curriculum Content, and a choice between CS 565, Computer-Assisted Instruction, and CS 566, Practicuum

in the Application of Computers in Education. The core group was designed to provide training in the academic computer science areas that are most important to teachers as well as an in-depth examination of topics of importance to those who are designing and implementing computer science courses in high schools.

CS 560, Computer Science in the Classroom, emphasizes commonly used programming languages and their use in the classroom. A discussion is included of how and what to teach in a high school computer science course. CS 561 and 565 concentrate on the organization and preparation of computer-based instructional units and their implementation in secondary schools. CS 566 offers supervised experience in the development of computer-based teaching units for disciplines other than computer science. According to a 1976 article by the program director, CS, 485, Computers and Society, was included in the program because secondary computer science teachers usually teach a unit on that subject in a high school course (Meinke and Bauer, 1976).

The core group represents a well-organized group of courses that are specifically designed to address the needs of high school computer science teachers. The elective program consists of twelve hours of coursework at the 400 and 500 levels. Students must plan, with the guidance and consent of their advisors, an elective program of courses

that are selected from the offerings of the computer science department or, when appropriate, from other departments. All of the 400-500 level computer science courses (other than those in the MST required core group) concentrate on aspects of computer science other than educational uses. Through the elective program, the student can acquire specialized knowledge about a particular area of computer science.

All students in the program must complete a five-hour project that deals with some aspect of computer science or with computer science as it is applied to another academic discipline. In addition, to receive the MST degree, students must pass a written comprehensive exam over the core curriculum.

The MST program is designed to produce individuals who have a sound computer science background and an in-depth understanding of the relationship between computer science and education. Graduates are particularly well-versed in the principles of teaching secondary computer science classes.

Bowling Green State University in Ohio

The computer science education program at Bowling Green State University is the only avenue that leads to certification in computer science in the state of Ohio. No state standards have been adopted, but an exception has been made

in the case of this one university in Ohio. Bowling Green State University offers a Bachelor of Science in Education that leads to certification in computer science. Both teaching majors and minors are available through this program.

Thirty hours of computer science coursework are required for a teaching major in computer science. Students must select either CS 101, Introduction to Programming, or CS 103, FORTRAN Programming. Both courses cover programming development and algorithm design using FORTRAN as a programming language. CS 103 requires prior extensive programming experience and CS 101 assumes no prior experience.

Six other computer science courses are explicitly required for a computer science teaching major. These include CS 201, Assembler Language Programming, CS 205, Advanced Programming Techniques, CS 305, Data Structures, CS 306, Programming Languages, and CS 307, Computer Organization.

Although nine of the thirty hours are electives, it is stipulated that six of these nine hours must be at the 400 level. Five other computer science courses are excluded from the electives for a teaching major or minor.

Twenty-one semester hours are needed for a teaching minor in computer science. Students in this program also must have credit for either CS 101 or CS 103. Two other courses, CS 201 and CS 205, are required. The twelve

remaining hours are electives that have no course-level restrictions. The program at Bowling Green State University is strongly oriented toward development of competencies in the theoretical and technical aspects of computer science. The required courses are all part of the normal sequence of computer science courses taken by all computer science majors.

No courses that deal with the educational aspects of computing are included in the curriculum. CS 100, Computer Basics, which is specifically excluded from this program, includes discussions of social issues and BASIC programming. Many of the CS 100 topics are similar to those normally included in basic computer literacy classes, which many high schools may soon offer. Such a course could be very valuable to a high school teacher.

The program at Bowling Green State University is a strong academic computer science program. Graduates are well-prepared for jobs as computer professionals but may have inadequate training in some areas of computing that are most important to high school teachers. If predictions of the downward migration of the college computer science curriculum are accurate, teachers with such in-depth training may be needed and sought by many high schools.

North Texas State University

Computer education has been an area of concern and attention at North Texas State University for several years. A wide variety of courses and programs has been developed to provide for the computer education needs of teachers in all phases of their training. Computer education programs available include specialized courses at the graduate and undergraduate level, computer science teacher certification programs, and an interdisciplinary master's degree program in computer-based educational systems. Two doctoral programs within the College of Education allow concentration in the area of computer science.

A review of all the programs, both at the undergraduate and graduate level, could be productive for those who are planning to meet the computer education needs of other colleges and universities. Since this study is delimited to an examination of the state-approved certification programs that were identified by state certification officers, only the certification programs at North Texas State University are summarized.

North Texas State University offers a 124-semester hour program that leads to a Bachelor of Science degree in secondary education. A major component of this program is academic specialization. One plan for academic specialization requires first and second teaching fields, both

selected from a list of approved teaching fields. Computer science is designated as an approved teaching field.

A minimum of twenty-seven semester hours of computer science coursework is required for a first teaching field. Four computer science courses--110, 111, 310, and 410--are explicitly required. Fifteen additional hours of computer science electives, of which at least nine are advanced, must be selected. For a second teaching field, however, only twenty-four hours of computer science coursework are needed. In this case, the same four required courses (CSCI 110, 111, 310, and 410) are required as well as twelve hours of computer science electives, with a minimum of six hours in advanced courses.

The first two required courses, CSCI 110, Introduction to Computer Science, and CSCI 111, Program Development, are beginning and advanced courses in program and algorithm design using a high-level language. The language used in the first course is BASIC, but the language in the second course is not specified. The second course also covers principles of structured programming, which could imply that a more modern structured language is used.

The two other required courses are CSCI 310, Computer Systems Analysis, and CSCI 410, Computer Science for the Teacher. The titles of both of these courses provide

accurate descriptions of course content. Catalog descriptions of all four required courses are in Appendix I.

Since only twenty-four hours of coursework are needed for certification in Texas, students who complete the requirements for computer science as either a first or second teaching field are eligible for certification in computer science in the state of Texas. Through the program offerings at North Texas State University, computer science certification may be obtained by both pre-service teachers who are seeking initial certification and in-service teachers who are seeking credentials in an additional teaching field.

University of Wisconsin at Green Bay

The University of Wisconsin at Green Bay offers an undergraduate degree program through the Department of Education that leads to a bachelor's degree in education with a teaching minor in mathematics-computer science. The program, which was instituted about five years ago, was the second computer science certification program established in the state. Students who complete the program are eligible for state certification to teach computer science in grades seven through twelve.

The teaching minor must be taken in conjunction with an appropriately related teaching major. Most students enrolling in the program pursue a teaching major in mathematics.

All computer science courses are taught under mathematics course numbers by mathematics department faculty.

The teaching minor requires a minimum of twenty-five semester hours of math coursework. Eight courses, covering all twenty-five hours, are explicitly required. The methods course in mathematics and student teaching in computer science or mathematics is required. Seven math courses are designated as approved electives in this curriculum.

Three of the eight required courses (eleven of the twenty-five required hours) are traditional mathematics courses. These include MATH 202, Calculus and Analytic Geometry I, and MATH 203, Calculus and Analytic Geometry II, both of which are four semester hour courses, and a three-hour course, MATH 320, Linear Algebra.

The remaining five required courses are normally considered to be computer science courses. The first three of these courses, which are MATH 255, FORTRAN: A Specific Programming Language, MATH 256, Introduction to Computer Science I, and MATH 257, Introduction to Computer Science II, concentrate on aspects of programming and algorithm design using a high-level language. MATH 256 and 257 are three credit hours each; MATH 255 is a two credit hour course.

The other two required courses are MATH 351, Data Structures, Storage, and Retrieval, and MATH 353, Computer

Organization and Programming, both three credit hour courses. The material included in MATH 351 matches closely the course content of most data structures courses. A major component of MATH 353 is a thorough study of assembly language programming in addition to an overview of computer organization.

All of the courses in the elective group are computer science courses. Since most of the students are also seeking teaching majors in math, it is possible that the eleven hours of traditional math courses in the required group might be counted in the math major. Eleven hours would then be taken from the elective group. Included in this group are MATH 350, Numerical Analysis, MATH 354, Compiler Theory, MATH 450, Theory of Algorithms, MATH 451, Data Base Management Systems, MATH 453, Systems Programming, and MATH 455, Microprocessors and Microcomputer Systems, all of which are three credit hour courses. A one-hour course, MATH 359, Computer Simulation, may also be elected.

The required and elective courses identified are all courses in the computer science curriculum that a person who is seeking a teaching minor is allowed to take for credit toward the minor. No courses are offered in the sequence that deal with the educational aspects of computer science.

For a computer science teaching minor, students are required to take a course in the materials and methods of

teaching secondary mathematics. From the information provided, it is unclear whether any part of the methods course is devoted to the teaching of computer science. Students could choose, however, to do student teaching in computer science.

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CHAPTER VI

REPORT ON OPINIONS OF SELECTED LEADERS IN THE FIELD OF COMPUTER SCIENCE EDUCATION

This chapter includes tabulations of the responses of the selected leaders in the field of computer science education to the survey on the nature of computer science education and the content of teacher training programs. The questionnaire was mailed to forty selected leaders in the field. Thirty-nine of the questionnaires, which represents 97 per cent of the sample, were returned. Follow-up procedures employed were reminder letters and telephone requests. It is worthy of note that thirty-five questionnaires were returned in response to the initial mailing without additional solicitation.

This report is divided into four parts, with each part containing the data collected from one of the four sections of the survey instrument and the analysis of that data. The first part presents the results of section A, which deals with opinions on general issues in computer science education. The next part presents the information collected in section B, which concerns computer science courses most appropriate for programs that train computer

science teachers. The third part describes the data collected in part C, the identification of the high-level languages that a teacher should know. The final part contains the replies to the open-ended question in section D of concluding remarks.

Opinions on General Issues in Computer Science Education

Respondents were asked to express their opinions using a five-point scale on eighteen items dealing with the nature of computer science education. These items, numbered as they appear on the survey instrument, are shown in Table II. Each individual's responses to the items is depicted in Table III. Respondents are numbered in Table III according to the numeric code used on the survey forms for the purpose of follow-up solicitations.

The intent of this study was to examine the entire group's opinion on each item rather than an individual's response to each item. Therefore, Table III is included for the purpose of completeness in the presentation of the data but not for analysis of results.

Frequency counts of the number of times each of the five possible responses is given to each item and the mean of the responses to the item are shown in Table IV. Items in Table IV are identified by number on the survey form. Table II may be consulted for the exact wording of the item.

TABLE II

GENERAL ISSUES IN COMPUTER SCIENCE EDUCATION

Item Number	Item Content
1	Computer science is a distinct discipline not a part of any other subject.
2	Basic computer literacy should be required of all high school graduates.
3	There are enough full-time positions for teachers of computer science, that a computer science teacher will not need certification in another area of specialization to be employed.
4	Most administrators support the introduction of computer science into the high school curriculum.
5	Certification of computer science teachers is a national problem that demands immediate attention.
6	By 1990, the first-year computer science courses now being taught in most colleges and universities will be taught in high school.
7	Cost of computer hardware is no longer a major deterrent to the introduction of computer science into the high school curriculum.
8	More indepth training is needed for a teacher who will teach about computers than one who simply uses computers in the classroom.
9	In the near future, most high schools will form computer science departments.

TABLE II--Continued

Item Number	Item Content
10	Computer literacy is the next great crisis facing American education.
11	Most parents feel that computer education should be a part of their child's general education.
12	Colleges and universities must act quickly to develop computer education programs to train prospective teachers of computer science.
13	Teachers of computer science should be certified in the area of computer science and not in another subject field which encompasses computer science.
14	There is a definite downward movement of the computer science curriculum now found in colleges and universities into the high school.
15	A major barrier to the implementation of high school computer science courses is the lack of a supply of adequately-trained teachers.
16	Credit for a high school computer science course should be given as a unit of computer science and not a unit of math, science, or business.
17	Most teachers feel that computer science should be included in the general education of all students.
18	There are now many programs in this nation designed to train computer science teachers.

TABLE III

INDIVIDUAL RESPONSES TO GENERAL ISSUES
IN COMPUTER SCIENCE EDUCATION

	Survey Items 1 through 9								
Respondent	1	2	3	4	5	6	7	8	9
1	2	1	1	2	1	2	1	1	2
2	1	1	4	2	1	1	1	2	1
3	1	1	2	3	2	2	1	1	2
4	1	2	1	4	1	2	2	1	4
5	4	1	1	4	2	1	1	1	1
6	1	1	2	3	1	1	2	1	4
7	3	1	4	2	1	1	1	1	4
8	2	1	4	2	2	2	2	1	4
9	1	1	1	2	1	1	2	1	3
10	2	2	2	2	2	2	4	1	2
11	1	2	4	2	1	2	2	1	3
12	2	1	5	4	1	2	1	2	4
13	3	1	2	4	1	1	5	1	2
14	2	1	4	3	3	1	2	2	4
15	2	1	3	2	2	2	4	2	2
16	1	1	4	3	2	3	3	1	3
17	1	1	3	3	2	1	2	1	2
18	1	1	3	1	1	1	1	1	4
19	1	1	4	4	3	5	2	1	4
20	4	1	4	2	2	1	1	1	3
21	2	1	3	1	1	1	2	1	4
22	1	1	2	2	1	1	2	1	2
23	1	1	4	2	4	2	4	1	4
24	4	1	4	4	2	2	2	2	2
25	1	2	2	2	2	2	2	1	3
26	1	2	1	2	2	2	4	2	4
27	.	.	.	.	.	.	.	.	.
28	1	1	1	3	1	1	4	1	2
29	1	1	1	4	1	1	1	1	2
30	1	2	2	2	2	2	2	2	3
31	2	2	3	4	2	5	2	2	3
32	1	1	3	4	4	1	1	1	5
33	2	1	4	4	1	1	2	2	4
34	1	1	2	3	3	2	2	1	4
35	4	2	4	2	1	2	2	1	4
36	2	1	2	3	3	2	2	1	3
37	1	1	2	2	1	1	1	1	4
38	1	2	3	2	1	1	1	1	2
39	4	5	5	2	5	5	4	1	4
40	2	1	2	1	1	2	1	2	4

*Response Scale: 1 = Very Strongly Agree; 2 = Agree; 3 = No Opinion; 4 = Disagree; 5 = Very Strongly Disagree

Survey Items 10 through 18

10	11	12	13	14	15	16	17	18
2	2	1	2	1	1	1	1	5
1	1	1	1	1	1	1	5	1
2	2	1	1	1	1	1	3	4
5	2	1	1	1	1	1	5	5
1	2	1	2	5	1	2	2	4
3	2	2	2	1	2	2	2	5
4	3	1	2	1	4	2	3	4
4	4	2	4	2	2	2	4	4
2	2	1	1	1	1	1	2	5
3	1	1	1	2	1	1	4	4
1	2	1	1	2	1	1	1	4
4	2	1	4	2	2	2	2	4
1	1	1	2	1	1	4	4	5
3	4	2	3	2	4	4	4	5
2	2	2	2	2	2	2	2	3
3	3	2	2	1	2	2	3	3
1	1	1	1	1	1	1	1	4
4	2	1	2	1	2	2	2	5
3	5	2	2	2	2	3	5	1
1	2	1	2	1	1	3	3	5
1	2	1	2	4	2	2	4	4
1	1	1	1	2	2	1	2	4
2	2	3	4	2	2	2	3	3
2	2	1	3	1	2	2	1	4
2	2	1	1	2	1	1	2	2
4	2	2	1	2	2	2	3	5
.	.	.	.	.	.	.	.	.
2	3	1	1	1	1	1	3	5
2	2	1	1	1	1	1	4	4
3	2	2	1	2	1	3	3	5
5	2	3	2	2	1	2	4	5
1	1	1	5	2	1	5	1	2
4	2	1	2	2	1	2	1	4
2	2	1	3	2	1	1	1	5
4	2	1	2	2	2	3	4	4
2	2	2	4	1	1	1	3	4
1	1	1	1	1	1	2	2	5
2	2	1	2	1	1	3	3	3
5	2	5	5	4	2	3	3	5
1	2	1	2	2	1	2	2	5

TABLE IV

FREQUENCIES AND MEANS OF RESPONSES TO GENERAL ISSUES IN COMPUTER SCIENCE EDUCATION

Survey Item	Frequency of Responses (N = 39)					
	Very Strongly Agree	Agree	No Opinion	Dis-agree	Very Strongly Disagree	Mean
1	21	11	2	5	0	1.76
2	29	9	0	0	1	1.33
3	7	11	7	12	2	2.76
4	3	18	8	10	0	2.64
5	19	13	4	2	1	1.79
6	18	17	1	0	3	1.79
7	13	18	1	6	1	2.07
8	29	10	0	0	0	1.25
9	2	11	8	17	1	3.10
10	11	12	6	7	3	2.46
11	7	26	3	2	1	2.07
12	27	9	2	0	1	1.43
13	14	16	3	4	2	2.07
14	18	18	0	2	1	1.71
15	23	14	0	2	0	1.51
16	14	16	6	2	1	1.97
17	7	10	11	8	3	2.74
18	2	2	4	15	16	4.05

Item nineteen in this section of the survey instrument is an open-ended question asking for additional comments or insights about the general nature of computer science education. The remarks of the nineteen individuals who responded to this item on the survey form are included in Appendix J. These comments address many issues over a broad range of topics. Rather than force a classification onto the comments, the comments are presented in random order without any relationship to the numbering of respondents in Table III. Many worthwhile ideas are presented in the comments. Discussion of the individual comments would be a complex and lengthy matter beyond the scope of this study. The comments are not, therefore, individually analyzed.

The data are perhaps more descriptive for analysis when expressed in terms of percentages rather than frequencies. In Table V, the number of times each response was given to an item is expressed in terms of percentage of the total number of responses to the item.

Inspection of Table V data reveals that over 65 per cent of the respondents agree very strongly with items two, eight, and twelve. Such a strong response to these items indicates overwhelming support for the ideas expressed.

In particular, the respondents clearly indicate their feelings that computer literacy should be required of all high school graduates. There is strong agreement with the

TABLE V

PERCENTAGE OF EACH RESPONSE TO EACH ITEM ON GENERAL ISSUES IN COMPUTER SCIENCE EDUCATION

Survey Item	Percentage of Responses (N = 39)				
	Very Strongly Agree	Agree	No Opinion	Dis-agree	Very Strongly Disagree
1	53.84	28.20	5.12	12.82	0.00
2	74.35	23.07	0.00	0.00	2.56
3	17.94	28.20	17.94	30.76	5.12
4	7.69	46.15	20.51	25.64	0.00
5	48.71	33.33	10.25	5.12	2.56
6	46.15	43.58	2.56	0.00	7.69
7	33.33	46.15	2.56	15.38	2.56
8	74.35	25.64	0.00	0.00	0.00
9	5.12	28.20	20.51	43.58	2.56
10	28.20	30.76	15.38	17.94	7.69
11	17.94	66.66	7.69	10.25	5.12
12	69.23	23.07	5.12	0.00	2.56
13	35.89	41.02	7.69	10.25	5.12
14	46.15	46.15	0.00	5.12	2.56
15	58.97	35.89	0.00	5.12	0.00
16	35.89	41.02	15.38	5.12	2.56
17	17.94	25.64	28.20	20.51	7.69
18	5.12	5.12	10.25	38.46	41.02

idea that more in-depth training is needed for teachers who teach about computers than for those who simply use computers in the classroom. Consistent with these findings is concurrence with the idea that colleges and universities must act quickly to develop computer education programs to train prospective teachers of computer science.

Item eighteen is the only item that produced strong disagreement. Although the level of disagreement for the item (there are now many programs in the nation designed to train computer science teachers) is far lower than the high level of strong agreement for items already mentioned, it is notable when compared to the low levels of disagreement on other items.

Indicators of general agreement or disagreement with the other fourteen items are best derived when the responses are grouped into three categories. Table VI data combine the frequencies of those who agree or very strongly agree into one figure and the frequencies of those who disagree or very strongly disagree into another figure. The number of no opinion responses is left unchanged from Table IV.

Table VI data also reveals the unanimous agreement with item eight, which deals with the need for in-depth training by those teaching about computers. Analysis of these data is further enhanced when these frequencies, expressed in

TABLE VI

CUMULATIVE FREQUENCIES OF RESPONSES TO GENERAL ISSUES IN COMPUTER SCIENCE EDUCATION

Survey Item	Cumulative Frequency (N = 39)		
	Agree or Very Strongly Agree	Disagree or Very Strongly Disagree	No Opinion
1	32	5	2
2	38	1	0
3	18	14	7
4	21	10	8
5	32	3	4
6	35	3	1
7	31	7	1
8	39	0	0
9	13	18	7
10	23	10	6
11	33	3	3
12	36	1	2
13	30	6	3
14	36	3	0
15	37	2	0
16	30	3	6
17	17	11	11
18	4	31	4

terms of number of responses, are converted to a cumulative percentage of total responses as shown in Table VII.

According to the data in Table VII, there is over 75 per cent general agreement with nine items in addition to the three items, numbers two, eight, and twelve, already discussed. Items in this category are numbers one, five, six, seven, eleven, thirteen, fourteen, fifteen, and sixteen. More than half of the respondents generally agree with items four and ten. Thus, there is a tendency towards agreement with these two items, but not at the 75 per cent level of the other nine items.

The areas of agreement indicate strong feelings about the emergence of computer science as a discipline in the high schools and the certification of computer science teachers. In particular, it is generally agreed that computer science is a distinct discipline, not a part of any other subject area and that teachers of computer science should be certified in computer science and not in another subject field encompassing computer science. Certification of computer science teachers is perceived as a problem that demands immediate attention. In addition, those surveyed feel that credit for a high school computer science course should be given as a unit of computer science and not as a unit of mathematics, science, or business.

TABLE VII

CUMULATIVE PERCENTAGES OF RESPONSES TO GENERAL ISSUES IN COMPUTER SCIENCE EDUCATION

Survey Item	Cumulative Percentage (N = 39)		
	Agree or Very Strongly Agree	Disagree or Very Strongly Disagree	No Opinion
1	82.05	12.82	5.12
2	97.43	2.56	0.00
3	46.15	35.89	17.94
4	53.84	25.64	20.51
5	82.05	7.69	10.25
6	89.74	7.69	2.56
7	79.48	17.94	2.56
8	100.00	0.00	0.00
9	33.33	46.15	20.51
10	58.97	46.15	20.51
11	84.61	7.69	7.69
12	92.30	2.56	5.12
13	76.92	15.38	7.69
14	92.30	7.69	15.38
15	94.87	5.12	0.00
16	76.92	7.69	15.38
17	43.58	28.20	28.20
18	10.25	79.48	10.25

The respondents perceive a definite downward movement of the computer science curriculum now found in colleges and universities into the high school curriculum. There is strong opinion that by 1990, the first-year computer science courses now taught in colleges and universities will be taught in high school.

Although cost of computer hardware is no longer viewed as a major deterrent to the introduction of computer science into the high school curriculum, the lack of a supply of adequately-trained computer science teachers is seen as a major barrier. Respondents indicate that most parents feel that computer education should be a part of their children's general education.

The level of general agreement on all items discussed in the preceding paragraphs is above 70 per cent. On two other items, there is a tendency towards agreement. Over 50 per cent of those surveyed believe that computer literacy is the next great crisis facing American education. A majority also accept the notion that most administrators support the introduction of computer science into the high school curriculum.

The biggest problem area, as indicated by these data, is the attitudes of the teachers. Less than half of the respondents believe that teachers support the inclusion of computer science as a part of the general education of all

students. In fact, almost 30 per cent of those responding chose the no opinion option in response to the item dealing with the attitudes of teachers.

Opinions were fairly evenly divided on items three and nine. In neither case is there a majority opinion. In both cases, a substantial number of respondents chose the no opinion option. More respondents agree than disagree with item three. The data are not conclusive, however, about whether or not there are enough full-time positions for teachers of computer science so that computer science teachers should not need certification in another area of specialization in order to be employed. Through the years, the problem of employment has been one of the chief factors cited by even the most avid proponents of computer science education as a major reason not to offer computer science certification. It appears from this survey that the argument against certification because of employment problems is still valid in the minds of some and that others are unsure if conditions have changed and venture no opinion.

While there is no majority opinion on item nine, more respondents disagree than agree that in the near future most high schools will form computer science departments. It is of interest that all but two of the seventeen respondents disagreeing with this item also agree that the first year computer science courses now taught in college will be

taught in the high school by 1990. Likewise, all but two agree that there is a definite downward movement of the college computer science curriculum into the high school. Therefore, no certain conclusions can be drawn from the survey on the issue brought up by the item.

Analysis and Summary

The opinions expressed in this survey point towards a possible bright future for computer science in the high school. Computer science is emerging, in the opinion of those surveyed, as a discipline in high schools, with a trend seen towards movement of the more academic computer science courses now taught in college into the high school.

Respondents indicate that academic credit for computer science courses should be given as a unit of computer science and that teachers should be certified in computer science. Certification of computer science teachers is identified as a problem that warrants immediate attention.

Parents and school administrators support the introduction of computers into the high school. Respondents feel that computer literacy should be required for high school graduation. Colleges and universities should act quickly to develop programs to provide the in-depth training needed by computer science teachers. Those surveyed indicate that few programs are now in existence.

Implications

Although opinions were fairly evenly divided on the other issues, the overwhelming agreement on the issues cited should carry with it broad implications to the educational community. Educators should become aware of the coming of the computer age to education and the implied responsibilities that accompany its arrival. Plans should be made now to implement computer education in high schools, including the preparation of an adequate supply of qualified, well-trained teachers. Standards should be adopted so that teachers with appropriate preparation can be certified in the field of computer science and be encouraged to pursue a career as a computer science teacher.

Opinions About Computer Science Courses Most Appropriate for a Program to Train Computer Science Teachers

The purpose of this section of the survey instrument was to identify those courses most appropriate for computer science teachers. Respondents were asked to designate a maximum of six courses from a list of twenty-four possible courses to be part of a required group of courses. A maximum of six courses were to be picked for an elective group. An option was available to write in other courses which might be more appropriate than the twenty-four listed.

Opinions About A Course on the Materials and Methods of Teaching Computer Science

Prior to choosing the required and elective courses, respondents were asked to reply to an open-ended question about a course in the materials and methods of teaching computer science. In some of the programs examined by the researcher, such a course was part of the professional education component and in others it was a computer science course. Due to the conflict about the proper place for such a course, it was not included in the list of courses.

Respondents were asked to express their opinions about the appropriateness of the course and its proper place in the curriculum. The comments of the eleven individuals who replied to the open-ended question are transcribed in Table VIII. The comments are numbered so that they may be easily referenced in the following discussion. The order of the listing of the comments does not relate to the numbering of respondents in Table III.

Of the eleven comments, nine can be interpreted to be in favor of inclusion of such a course in a computer science teacher training program. The exact intentions of two comments are unclear. Comment five, not required, could be interpreted in several ways, minimally that such a course should not be required. Whether such a course is considered

TABLE VIII

COMMENTS ABOUT A COURSE IN THE MATERIALS AND METHODS OF TEACHING COMPUTER SCIENCE

Reference Number	Comment
1	Yes, there should be a methods course - who teaches it is not important as long as they are competent.
2	Everyone who is a certified teacher should have a methohds class in their subject area which includes use of a computer. An optional and more extensive class on computer use (not programming) should also be offered.
3	The course is essential. Should normally (given qualified faculty) be taught in the educational department. So should some of the introductory computer science courses.
4	I think it should be included. The teachers and students in these programs (computer science) will, like it or not, become a resource to other programs within the school. Therefore, they should have some idea about how other programs use and apply computers.
5	Not required.
6	I feel that such material is important in teacher training but I'm not such a purist that I believe it must be in one place or the other. Either will do.
7	For now, it must be in computer science. There simply is not the experience, in general, in schools of education. When we are strong enough to have departments of computer science education, then it can be done.

TABLE VIII--Continued

Reference Number	Comment
8	Belongs in whatever department has a person with both a) computer science background and b) direct experience teaching pre-college and strong teaching methods background.
9	I think it should be in the education component - team taught by educator and a computer science person.
10	I think it is appropriate; perhaps included in the "Computer and Education" course (No. 11).
11	Needed course in the professional education component.

appropriate is not clear. The exact meaning of comment two, and how it applies to the question, is also unclear.

In addition, comment ten supports inclusion of the course and suggests the possible inclusion of the course material within the framework of another course. The general opinion, however, with a small degree of dissent, of those responding seems to be strongly in favor of the inclusion of a course in the materials and methods of teaching computer science in programs that are designed to train computer science teachers.

Opinions were divided as to the proper place for this course. Three people feel that the course is properly a part of the education component of teacher training programs. One respondent commented that placement depends on the availability of qualified faculty. For another, the course should be team-taught by the computer science and education departments.

One individual considers the course to be the property of the computer science department by reason of lack of available expertise in the education department. Two respondents give no indication of the proper place for the course.

Three of the respondents believe that the exact placement of the course is not critical. More emphasis was

placed by these respondents on the qualifications of individuals who teach such courses.

The best general description of the responses to this section is that a course in the material and methods of teaching computer science is indeed appropriate and desirable in programs that train computer science teachers. For the present, the choice of the department that offers the course and the instructors for the course depend on the local expertise available.

Selection of Required and Elective Courses

Thirty-seven of the thirty-nine respondents answered the section devoted to the choice of required and elective courses that should be included in programs designed to train computer science teachers. The raw data, showing which courses were selected by each individual, is used to generate frequency counts for each course.

Respondents had the option of writing in additional courses rather than limiting their choices to the list of courses provided. Several individuals chose this option and picked some of the courses from the list on the form and wrote in others, still limiting the total number of courses to a maximum of six required courses and six elective courses. Only two of the courses written in could be considered to be equivalent. In all other cases, the course written in was the selection of only one individual. None

of these additional courses was found with sufficient frequency to be a factor in the findings of this section.

A display of the raw data, listed by respondents, showing only selections from the twenty-four course list would unfairly depict the opinions of those who also wrote in courses. The data are displayed, therefore, in frequency tables based on the list of courses rather than individual responses. The written-in courses are presented in Appendix K.

In Table IX, the twenty-four courses are listed in the same order as on the survey form by the full name of the course. Also included are the number of times each course was selected as either required or elective and the total number of times selected. The ordering of the information in Table IX is convenient for location and examination of courses by number. In addition, Table IX gives a complete description of all the data compiled from this section of the survey instrument.

Required Courses.--These data are easier to understand and analyze when the list of courses is rearranged in order of selection. Table X aids in determining opinions about required courses. The courses are listed in order of frequency of selection as required courses, and only frequency of choice as a required course is shown. In cases where two courses were selected by the same number of people as a

TABLE IX

SELECTION OF COURSES APPROPRIATE FOR A COMPUTER SCIENCE TEACHER TRAINING PROGRAM (N = 37)*

Course		Frequency of Selection		
Number	Title	Required	Elective	Combined
1	Introduction to Programming and Algorithm Design	35	0	35
2	Advanced Topics in Programming and Algorithm Design	13	16	29
3	Introduction to Computer Systems	14	10	24
4	Assembly Language Programming	10	9	19
5	Fundamentals of Computer Organization and Digital Logic	10	11	21
6	Introduction to File Processing	6	18	24
7	Operating Systems	2	12	14
8	Data Structures	12	11	23
9	Programming Languages	19	11	30
10	Computers and Society	21	10	31
11	Computers and Education	23	5	28
12	Computer Assisted Instruction	12	13	25
13	Minicomputer Systems	0	6	6

TABLE IX--Continued

Course		Frequency of Selection		
Number	Title	Required	Elective	Combined
14	Microcomputer Systems and Applications	15	9	24
15	Numerical Methods	1	6	7
16	Database Management Systems	4	13	17
17	Artificial Intelligence	1	13	14
18	Software Engineering	1	6	7
19	Computer Graphics	6	12	18
20	Compiler Design and Construction	0	1	1
21	Systems Programming	0	5	5
22	Theory and Design of Programming Languages	1	5	6
23	Simulation and Modelling	4	8	12
24	Advanced Computer Organization and Computer Architecture	0	2	2

*2 of the original 39 respondents did not answer this section.

TABLE X

REQUIRED COURSES SELECTED IN ORDER OF FREQUENCY OF SELECTION (N = 37)

Course		Frequency of Selection As A Required Course
Number	Title	
1	Introduction to Programming	35
11	Computers and Education	23
10	Computers and Society	21
9	Programming Language	19
14	Microcomputer Systems	15
3	Introduction to Computer Systems	14
2	Advanced Topics in Programming	13
12	Computer Assisted Instruction	12
8	Data Structures	12
5	Fundamentals of Computer Organization	10
4	Assembly Language Programming	10
6	Introduction to File Processing	6
19	Computer Graphics	6
16	Database Management Systems	4
23	Simulation and Modelling	4
7	Operating Systems	2
17	Artificial Intelligence	1
15	Numerical Methods	1
18	Software Engineering	1
22	Theory and Design of Programming Languages	1
13	Minicomputer Systems	0
21	Systems Programming	0
24	Advanced Computer Organization	0
20	Compiler Construction	0

required course, the course that was selected most frequently as an elective is listed first.

Nine additional required courses were written in by respondents. These courses are included in Appendix K. Both of the first two added courses deal with how to teach programming. These courses could be included in the category of the course in the materials and methods of teaching computer science that was the object of the open-ended question in the first part of this section on the survey form. Their inclusion here is an even stronger indication of the approval of those surveyed that such a course is a highly desirable element of a teacher training program.

All of the other added courses are the selections of just the individual including them in the list. These courses have, therefore, a frequency equivalent to that of the four courses in the original list that were selected once. Sixteen courses on the list of twenty-four courses have a higher frequency count. Unless the required course group of a program contains more than sixteen courses, none of the added courses is selected often enough to warrant inclusion in the required group.

Respondents were restricted to the selection of a maximum of six required courses. Four courses were selected by over 50 per cent of the respondents to be included in a required group of courses. These include Introduction to

Programming and Algorithm Design, Computers and Education, Computers and Society, and Programming Languages. To complete a six-course required component, the next two most frequently selected courses, Introduction fo Computer Systems and Microcomputer Systems and Applications, should be included in the group of required courses.

The actual number of required computer science courses in any teacher training program will vary from institution to institution. No attempt to determine the ideal number of required courses was undertaken by this study.

At the beginning of the study, it was felt that most states would require twenty-four to thirty semester hours of coursework for certification, that training programs would be based on the state requirements, and that few programs would require more than eighteen hours and not allow students to elect some courses. Therefore, the decision was made to restrict the number of choices in the hope of identifying those courses most beneficial to computer science teachers.

Those in charge of designing such programs should not feel limited to six required courses or obligated to include as many required courses. The information provided in Table X could be used as a guide when considering selection of courses for required components of teacher training programs.

Opinions about the first four courses in Table X were strong enough that these courses should receive a great deal of consideration for inclusion in all programs. Only five respondents chose to include both Microcomputer Systems and Applications and Introduction to Computer Systems in the same required group. A sound argument could be made for inclusion of only one of these courses in the required group or requiring one of the two courses. In these cases, the next most popular course, Advanced Topics in Programming, could be placed in the required group.

Elective Courses.--Respondents were asked to pick a maximum of six courses to be part of an elective group of computer science courses included in teacher training programs. Choices could be made from the twenty-four courses listed on the survey form or by writing in other courses considered more appropriate than the courses in the list.

Table XI lists the twenty-four courses along with the number of times each was selected as an elective course. In some cases, the course name has been abbreviated. Table IX shows the full title of each course. Courses are listed in Table XI in the order of frequency of selection as an elective course. Courses with equal elective frequencies are listed in order of selection as required or elective courses combined.

TABLE XI

ELECTIVE COURSES SELECTED IN ORDER OF FREQUENCY OF SELECTION (N = 37)

Course		Frequency of Selection As An Elective Course
Number	Title	
6	Introduction to File Processing	18
2	Advanced Topics in Programming	16
12	Computer Assisted Instruction	13
16	Database Management Systems	13
17	Artificial Intelligence	13
19	Computer Graphics	12
7	Operating Systems	12
9	Programming Languages	11
8	Data Structures	11
5	Computer Organization	11
10	Computers and Society	10
3	Introduction to Computer Systems	10
14	Microcomputer Systems	9
4	Assembly Language Programming	9
23	Simulation and Modelling	8
15	Numerical Methods	6
18	Software Engineering	6
13	Minicomputer Systems	6
11	Computers and Education	5
22	Theory of Programming Languages	5
21	Systems Programming	5
24	Advanced Computer Organization	2
20	Compiler Construction	1
1	Introduction to Programming	0

The six courses written in as elective courses are included at the end of Appendix K. Since none of these six courses appears on more than one survey form, they all have a frequency count of one, which is surpassed by all but two of the twenty-four courses in the master list. Therefore, none of the added elective courses was selected frequently enough to warrant consideration for inclusion in an elective group.

Determination of an appropriate elective group could be made through analysis of Table XI, which represents selection only as an elective course. Reasonably, anyone selecting a course to be part of a required group could also consider the course an appropriate elective. More valid selections may possibly be found by combining the frequencies of selection for both required and elective courses, as shown in Table XII.

Table XII lists all twenty-four courses in order of their combined frequency of selection. Some course names are abbreviated, and Table IX should be consulted for the entire course title. Courses that were selected an equal number of times are listed in Table XII in the same order they appeared on the survey form.

If a computer science education program is divided into required courses and elective courses, then those courses that are required would not be part of the elective group.

TABLE XII

COURSES SELECTED FOR EITHER GROUP
IN ORDER OF COMBINED TOTALS
(N = 37)

Course Number	Course Name	Frequency of Selection Either Group
1	Introduction to Programming	35
10	Computers and Society	31
9	Programing Languages	30
2	Advanced Topics in Programming	29
11	Computers and Education	28
12	Computer Assisted Instruction	25
14	Microcomputer Systems	24
3	Introduction to Computer Systems	24
6	Introduction to File Processing	24
8	Data Structures	23
5	Computer Organization	21
4	Assembly Language Programming	19
19	Computer Graphics	18
16	Database Management Systems	17
17	Artificial Intelligence	14
7	Operating Systems	14
23	Simulation and Modelling	12
15	Numerical Methods	7
18	Software Engineering	7
22	Theory of Programming Languages	6
13	Minicomputer Systems	6
21	Systems Programming	5
24	Advanced Computer Organization	2
20	Compiler Construction	1

In the design of such programs, it would be advantageous to determine the required courses first and then select courses from Table XII for the elective group.

A required group of six courses was proposed in an earlier section in this chapter. Five of the first six courses in Table XII were included in the proposed required group. To aid in the selection of elective courses, all courses except the proposed required courses are shown in Table XIII along with the associated combined frequencies.

The stated method to be followed by this study for selection of an elective group was to pick the six most popular courses remaining after choosing the required group. Arguments could be made that almost any computer science course could be of benefit to a teacher and is therefore a valid elective. The attempt of this study was to ask those who are in a position to render an opinion judge which courses are most beneficial and appropriate. Therefore, respondents were limited to six elective choices.

A possible use of this study would be to leave the choice of elective courses open to the student but to suggest courses receiving a strong degree of support as indicated by Table XIII to those students desiring guidance about choice of electives. Others may feel that restricting the choice of electives to a prescribed group of courses is the most appropriate action. There is a definite break in

TABLE XIII

COMBINED TOTALS FOR ALL COURSES EXCLUDING THE FIRST SIX MOST POPULAR REQUIRED COURSES (N = 37)

Course Number	Course Name	Frequency of Selection Either Group
2	Advanced Topics in Programming	29
12	Computer Assisted Instruction	25
6	Introduction to File Processing	24
8	Data Structures	23
5	Computer Organization	21
4	Assembly Language Programming	19
19	Computer Graphics	18
16	Database Management Systems	17
7	Operating Systems	14
17	Artificial Intelligence	14
23	Simulation and Modelling	12
15	Numerical Methods	7
18	Software Engineering	7
22	Theory of Programming Languages	6
13	Minicomputer Systems	6
21	Systems Programming	5
24	Advanced Computer Organization	2
20	Compiler Construction	1

the data between the eighth and ninth courses in Table XIII. A group of elective courses made up of the first eight courses in Table XIII would also be an excellent choice and would increase the student's options.

In the opinion of those surveyed, the six courses most appropriate for an elective group include Advanced Topics in Programming and Algorithm Design, Computer Assisted Instruction, Introduction to File Processing, Data Structures, Fundamentals of Computer Organization and Digital Logic, and Assembly Language Programming. Over 55 per cent of the respondents chose the first two courses and a majority selected the other four. The level of support for the entire group is a strong indictment for the inclusion of all the courses in the group in any computer science education curriculum. All of the courses, with the possible exception of Computer Assisted Instruction, are normally found in a computer science major curriculum and would be available at most institutions that offer computer science degrees.

Opinions About High-Level Languages in Which a Computer Science Teacher Should Be Proficient

The purpose of the third section of the survey form was to determine which high-level languages are most needed by high school computer science teachers. Respondents were given a list of nine languages, listed in alphabetical order, and they were instructed to select a maximum of three

languages as those appropriate for computer science teachers. An option was available to write in other languages that are more appropriate.

Results compiled from this section of the survey form are displayed in Table XIV. The courses are listed in Table XIV in the order that they appeared on the survey form. Data included are the number of people choosing each language and the percentage of respondents choosing the language. Three of the thirty-nine respondents who answered the survey items included in Tables III, IV, V, VI, and VII did not respond this section of the questionnaire. The percentages shown are in terms of the thirty-six responses to this section.

The only two languages written in were LOGO and assembly language. Most computer scientists would not consider assembly language to be a high-level language. For that reason, assembly language was not included as a choice on the survey. It was offered as the fourth course listed in the previous section of the survey. According to Table X, assembly-language programming was selected by nineteen people to be part of either a required or an elective group. Its inclusion by two individuals in this section simply adds to its importance as an elective component or as a possible substitution for a required course in teacher training programs.

TABLE XIV

OPINIONS ABOUT HIGH LEVEL LANGUAGES IN WHICH A COMPUTER SCIENCE TEACHER SHOULD BE PROFICIENT (N = 36)

Language**	Frequency of Selection	Percentage
ADA	3	8.33
BASIC	31	86.11
COBOL	8	22.22
FORTRAN	9	25.00
LISP	3	8.33
PASCAL	34	94.44
PL/I	1	2.78
SNOBOL	1	2.78

*3 of original 39 respondents did not reply to this section of the survey form.

**Added languages: LOGO was written in by 15 respondents representing 41.67 per cent of the 36 respondents. Assembly language programming was written in by 2 respondents representing 5.56 per cent of the 36 respondents.

Fifteen respondents added LOGO as an appropriate language. In the comments section, one individual, who chose only two languages in this section, wrote that he felt that teachers should have LOGO training but that he did not consider LOGO to be a language. If this response is included in the total of those writing in LOGO, the figure jumps from fifteen to sixteen respondents or 45.71 per cent of the respondents.

The only two listed languages chosen by a majority of the respondents are BASIC and Pascal. Only two people failed to select Pascal and five did not choose BASIC.

The overwhelming choice of BASIC is indeed noteworthy due to the ongoing arguments among computer scientists as to the value of or potential dangers of BASIC. The implication of this survey is that BASIC, despite any problems it might have, is needed by computer science teachers.

In summary, the respondents agree that Pascal and BASIC should be included as required language components of any computer science education curriculum. Exposure to LOGO should be strongly considered. FORTRAN and COBOL, which were chosen by over 20 per cent of the respondents, could be appropriate elective languages in such a program, followed by ADA and LISP.

Final Comments of the Respondents

The last section of the survey form is an open-ended question asking for any other comments the respondents wished to make. Fifteen respondents included answers to this question. The fifteen comments are transcribed in Table XV. The comments are numbered so that they can be easily referenced in the discussion. The numbers bear no relationship to the numerical order of respondents in Table III.

The comments cover a broad range of topics. Numbers two, five, and six concern certification issues. Comments three, four, nine, and fourteen are actually remarks about the survey form itself. Items numbered one, seven, eleven, twelve, and thirteen all center around issues involving teachers, not only computer science teachers, but in some cases, those teachers who use computers in the classroom. Other comments address individual issues not encompassed by the three classifications listed.

Many worthwhile issues are discussed. Again, discussion of most of the ideas is beyond the range of this study. Several of the points might be excellent objects of studies themselves.

In conclusion, although the comments are not analyzed individually, they do provide useful information. They give extra insights into some key issues of computer science

TABLE XV

FINAL COMMENTS OF SELECTED LEADERS IN THE FIELD OF COMPUTER SCIENCE EDUCATION

Reference Number	Comment
1	A person with the background I feel is necessary, will go into industry (25k) instead of teaching (15k). More's the pity!!
2	I assume you've gotten materials from Minnesota, Oregon, and Ohio (and any other state that has recently joined the ranks) for comparison of certification requirements??
3	Several of these questions contain leading qualifying/quantifying words that altered my responses from what they would have been to items not containing these terms.
4	Difficult to answer where so little choice available. Not sure what results will prove.
5	The idea of "national certification" concerns me. This has always been a responsibility of the states, and to change it for a particular subject area would require some strong arguments. Even then I doubt it would be successful.
6	I hope that certification will become a reality.
7	You are only thinking, it appears, of computer science teachers. What about computer courses for all teachers (required) to enable them to use the new technology throughout the curriculum K-12?

TABLE XV--Continued

Reference Number	Comment
8	Programming will change dramatically in the next 5-10 years!
9	Need to distinguish between preparation for an elementary teacher and a secondary teacher! Several topics listed in 8 needed to be included in one course, i. e. too specialized to be included in one class.
10	1) We should not rush judgement on requirements. Curriculum '68, '78 were successful because a) it provided a taxonomy of the field b) it provided ample options and alternative choices to fit local needs and interests (and equipment) and it was closely monitored to identify immediate problems. Languages tend to be important because of applications to be used as reactions to poor design of previous languages to specific sets of applications. Therefore, requirements should be broad and dynamic.
11	1) Right on! - very timely and of immense importance 2) Don't think only of upper division high school teachers. Most jr. high teachers will be taking a one-semester computer course with a strong focus on programming. These teachers need to know a lot of computer science if they are to do a decent job.
12	A computer science degree should be designed so the teacher can teach students to program. Not to use computers, design games, etc.

TABLE XV--Continued

Reference Number	Comment
13	Very worthwhile questions to consider here. Let's all get together sometime. People who are teaching programming at the high school level and college professors and professional computer users and start to discuss these things.
14	Don't know exactly what proficient means for languages but some variety is important.
15	Right on!!

education as well as some areas of conflict among those in the field. For this reason, the comments are included in this report of the data collected by this study.

CHAPTER VII

COMPARISON OF EXISTING PROGRAMS AND THE IDEAL PROGRAM AS PERCEIVED BY NATIONAL LEADERS

The purpose of this chapter is to examine similarities and differences among the five state-approved programs that are reviewed in Chapter V and to compare their content to the curriculum selected by the respondent leaders in the field of computer science education. The chapter is divided into two major sections. The first section presents a comparison of the existing programs, and the last compares the programs as a group with the opinions of the leaders in the field.

Similarities and Differences in State-Approved Programs

Five state computer science education programs were identified by state certification officers as representative of all the programs in the state. In the cases of Arizona, Illinois, and Ohio, the identified programs are the only state-approved programs. Four state-approved programs are presently offered in Texas. Wisconsin leads the nation with twelve state-approved programs.

Comparison of the programs is difficult due to the diverse nature of the programs. Two of the programs offer both undergraduate teaching majors and minors in computer science, two offer teaching minors only, and one is open only to graduate students. The number of hours of required computer science coursework ranges from eighteen to thirty-four hours, with the graduate program requiring additional computer science hours for entry to the program.

The programs at The University of Arizona, Illinois Institute of Technology, Bowling Green State University, and North Texas State University are divided into required and elective computer science core components. The number of explicitly required courses in these programs varies from four, totalling twelve semester hours, to seven courses, totalling twenty-one semester hours. None of these four universities specifically prescribes an elective group, but all of them place some restrictions on the level of the elective courses. Bowling Green specifically exludes some courses from elective credit.

Twenty-five semester hours of computer science coursework are required at the University of Wisconsin at Green Bay. A required group of courses that totals twenty-five hours, the total hours needed for the teaching minor, is specifically outlined. A group of courses is also identified as

approved electives for those who desire additional computer science coursework.

In three of the programs, all of the required courses are selected from the standard offerings of the computer science department, or in one case, the mathematics department, to all computer science majors. In only two programs are courses required that deal with computers and education.

Four of the programs require both an introductory and an advanced course in programming and algorithm design using a high-level language, and the fifth program requires both for entry. Three other courses that are required by a majority of the programs are Programming Languages, Data Structures, and Assembly Language Programming. Thus, there is general agreement on at least fifteen hours of the required components.

In summary, there is a great deal of variance in the five programs. Offerings range from a graduate program requiring thirty-two semester hours of computer science coursework plus additional hours of prerequisite coursework to an undergraduate program offering a teaching minor in computer science that requires eighteen hours of coursework. All of the programs have two courses in common. Three of the five programs require three of the same courses. In only one case were elective courses explicitly identified.

In all others, only the level of the elective was restricted.

Comparison of Programs with Opinions of the Selected Leaders

One section of the survey instrument that was completed by leaders in the field of computer science education is devoted to the identification of computer science courses most appropriate for computer science teacher training programs. Data from this section of the survey are presented in Chapter VI, Tables IX, X, XI, and XII.

A required group of six courses and an elective group of six courses was selected by the leaders. Respondents were asked to select courses most appropriate for such a program, trying not to guess which courses are actually in existing programs. The purpose of this section is to compare the courses selected by the leaders to the required courses in the five representative state programs.

Table XVI shows which of the required courses in the existing state programs are also part of the two groups selected by the leaders in the field. Courses selected by the leaders are listed in Table XVI in the order of selection. Since specific elective groups were not included in most of the state programs, no attempt was made to include elective courses in the state programs in the comparison.

TABLE XVI

COMPARISON OF THE REQUIRED COMPONENT OF STATE PROGRAMS WITH COURSES SELECTED BY THE LEADERS IN THE FIELD

Courses Selected By Leaders*	Programs**				
	UA	IIT	BG	NTSU	UW-GB
Required Courses					
Introduction to Programming	R	P	R	R	R
Computers and Education		P		R	
Computers and Society		R			
Programming Languages	R	R	R		
Microcomputer Systems					
Introduction to Computer Systems		P		R	
Elective Courses					
Advanced Topics in Programming	R	P	R	R	R
Computer Assisted Instruction		RC			
Introduction to File Processing					
Data Structures	R		R		R
Computer Organization			R		
Assembly Language	R	P	R		R

*Classification Code: R - Required course; RC - Required choice of this course or one other course; P - Prerequisite for entry to program.

**Key to Program Names: UA = The University of Arizona; IIT = Illinois Institute of Technology; BG = Bowling Green State University; NTSU = North Texas State University; UW-GB = University of Wisconsin at Green Bay.

Note: 1 course was required by the University of Arizona and 3 by Illinois Institute of Technology that are not in the list of 12 courses.

The data in Table XVI show that Introduction to Programming is a major component in all of the programs and the first choice of the leaders as a required course. Programming Languages, a required course in the opinion of the leaders, is required in three of the five state programs.

Most of the other required courses in the state programs are elective courses in the groups selected by the leaders. In particular, Advanced Topics in Programming is required in all five state programs but is only an elective in the opinion poll. The two other required courses that are shared by a majority of the state programs, Data Structures and Assembly Language Programming, attain only elective status according to the leaders.

Thus, there is general agreement on two required courses and disagreement on the status of three other courses. None of the other courses selected by the leaders appears with any regularity in the state programs.

Discussion of Inferences Drawn from the Comparisons

One possible explanation for the lack of agreement is that in most cases, the computer science course structure of the program was designed by the computer science department in consideration of the background that is most important to the development of general computer science competencies, not necessarily those needed by computer science teachers.

Due to other demands on faculty, some computer science departments may have felt unable to include any specialized offerings for teachers. Other departments may have decided that survey courses (such as Computers and Society and Computers and Education) are not true computer science courses and should not be counted as such.

The leaders also examined the problem from another angle--namely to select courses most appropriate for high school computer science teachers. The group's course selections in all but two cases disagree sharply with the programs now in existence. A close examination of the leaders' required group reveals that all of the selected courses relate directly to skills and competencies most needed by high school teachers.

In particular, two of the courses, Introduction to Computers and Programming Languages, help develop competencies needed by those who will teach programming classes in high school. Teachers will need the fundamentals of programming and have the ability to design curricula for the courses and make reasonable choices about which languages should be taught. They will be required to teach courses in several languages and will need a sound understanding of the basic characteristics of these languages.

In many schools, the computer science teacher is considered the computer expert at the school, and is called

on for expertise in many areas outside of the computer science classroom. The computer science teacher often must help decide how computers will be used in the entire learning process. Some must select both hardware and software for resource labs. They may assist in decisions concerning computerization of administrative functions. The computer science teacher may be responsible for the inservice training of other teachers on the use of computers in the classroom. The Computers and Education course can provide an overview of the use of computers in all phases of education and can help prepare teachers for the multiplicity of jobs and responsibilities of computer science teachers.

Based on the predictions of the leaders in the survey opinion poll and current trends in the United States, computer literacy soon will be required for high school graduation. The computer science teachers will, therefore, inherit the responsibilities of conducting computer literacy classes and preparing students to live in a computerized society. Teaching such a course involves knowledge of how the computer can be used in everyday life. In this light, a well designed course in Computers and Society is almost essential for computer science teachers.

Computer science teachers often must participate in decisions about the selection and purpose of computer

equipment, not only for the computer classroom, but also for the whole school. In most cases, computer science classes use the smaller, self-contained microcomputer systems. Teachers will need training in the use and care of such systems and all of the types of systems that might be found in schools. Introduction to Computer Systems and Microcomputer Systems and Applications are two courses that would be extremely useful and necessary to teachers who are faced with such decisions and limited to the use of systems that can be afforded by the schools. It seems only reasonable that school systems will and should expect such expertise from the computer science teachers.

Summary

Sound arguments can be made that all of the courses selected by the leaders are vitally important to prospective computer science teachers. Through well chosen elective courses, such as those common to the existing programs, teachers could broaden their computing backgrounds, and perhaps enhance their abilities as teachers.

The message conveyed by the group of concerned computer science educators is that the duties of a high school computer science teacher are quite different from those of a person who enters a position in industry with a computer science degree. The nature of the training for a career computer science teacher should be different. When design-

ing computer science education programs in the future, close attention should be given to this conceptual difference.

CHAPTER VIII

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The primary purpose of this study was to investigate the certification of high school computer science teachers. The study examined the issue from historical, present, and future standpoints.

An extensive review of the literature was conducted to determine the best-known history of computer science certification. A report on the current status of computer science certification was developed from data collected from a survey of state certification officers.

The first step in determining the need for certification in the future was to determine if a definite trend of movement of computer science into the high school could be detected. Such a trend would imply the need for more teachers of computer science as well as quality control measures on those teachers. The final step of the investigation centered on the development of a computer science curriculum for future certification programs as well as all programs designed to train computer science teachers.

Methods employed consisted of examination of data collected from the survey of state certification officers and

review of five representative state-approved computer science education programs. This information was compared to results of the opinion poll of selected leaders in the field of computer science education.

The forty leaders in the field of computer science education were a carefully selected group chosen by the formula outlined in the research procedures of Chapter III. Selection was based on the criteria of recognized contributions to computer science education, usually in the areas of certification, teacher training, or the teaching of computer science.

Individuals selected for the sample came from twenty-one different states and the District of Columbia. Among the group are more than twenty college professors, all currently active in the field. Officers of most of the national educational computing organizations are included. Editors of at least three major educational computing journals participated in the study. At least a quarter of the group serve on the advisory staffs of major computer education journals. Most of those included in the sample are major contributors to research and knowledge in the field and are widely published.

Five nationally recognized active high school teachers were included, three of whom have published in the last

year. Three were recently recognized for outstanding teaching as well.

Several individuals who serve as consultants to major school districts in the area of instructional computing were asked to participate. Others who have moved from the university to industry or private businesses are included in the sample.

At least one-fourth of the respondents have published major books on aspects of computer education. Many who are internationally known for their efforts have participated in international conferences and served on international committees that investigated computer science education.

The group carries with it an impressive set of credentials and combines hundreds of years of experience in computer science education. All have a proven interest and knowledge and are well qualified to express opinions on the issues presented by this study.

It is of singular importance that all but one of the group of forty leaders responded to the survey. A reasonable conclusion could be reached that the unusually large percentage of returns is due to the perceived importance of the issues at hand. The group assembled represents some of the best expertise available to answer the questions posed by this study. The group expressed strong and definite opinions that are worthy of serious consideration.

This study attempted to collect the best available data to answer the major research questions through contact with those who are in the best position to provide the needed information. Included in this group were the state certification officers and the leaders in the field of computer science education. A summary of the findings from these data include the following items.

1. Only four states have adopted computer science certification standards.

2. In one state which has no state computer science certification standards, computer science certification can be achieved through completion of the one state-approved computer science teacher training program in the state.

3. At least one third of the remaining states have adopted for the purpose of school accreditation regulations concerning which teachers are approved to teach high school computer science classes.

4. It is the opinion of the group of selected leaders in the field of computer science education that:

a. There is a definite, rapid, downward movement of the computer science curriculum that is presently found in colleges and universities into the high school.

b. Most parents favor the inclusion of computer education in the general education of all students.

c. Most school administrators support the introduction of computer science into the high school curriculum.

d. Although cost of computer hardware is no longer a major barrier to the implementation of computer science into the high curriculum, the lack of a supply of adequately-trained teachers is such a barrier.

e. More training is needed by teachers who teach about computers than those who only use them in the classroom.

f. There are few programs in existence today that are designed to provide training for high school computer science teachers.

g. Basic computer literacy should be required of all high school graduates.

h. Computer science teacher training programs should contain a course on the materials and methods of teaching computer science.

i. Computer science is a distinct discipline not a part of any other subject field.

j. Teachers of computer science should be certified in the area of computer science and not in another subject field which encompasses computer science.

k. Academic credit for a high school computer science course should be given as a unit of computer science.

5. A set of six required courses and six elective courses were identified as those most appropriate for computer science teacher training programs.

6. Computer science teachers should be proficient in the languages BASIC and Pascal.

Due to careful design, control, and selection, the data derived by this study are as valid as possible. Appropriate conclusions and recommendations may be drawn from the data. The remainder of this chapter is devoted to the presentation of conclusions and recommendations made as a result of this study.

Conclusions

Examination of the data collected by this study has lead to the following conclusions.

1. Computer science is a separate, distinct, certifiable subject field.

2. Certification of high school computer science teachers is a national problem that demands immediate attention.

3. Based on a survey of literature and the opinions of the selected leaders in the field of computer science education, computer literacy should be required for high school graduation, thereby making the need for certification more acute.

4. Certain types of computer science courses directly meet the needs of high school computer science teachers.

5. Computer science teacher certification programs should require computer science courses that develop proficiencies needed for duties as a teacher and then allow for the broadening of computer science ability through elective courses.

Recommendations

Based on all the evidence collected by this study, including a search of the literature and the opinions of the state certification officers and selected leaders in the field of computer science education, the following recommendations are made.

1. All states not currently offering computer science teacher certification should adopt standards in the near future.

2. Teachers of computer science should be certified in the field of computer science.

3. Educators must find a place for computer science *per se* in the high school curriculum.

4. Colleges and universities must act quickly to develop computer education programs to train computer science teachers.

5. All programs designed to train high school computer science teachers should include the following types of courses:

a. A course on the materials and methods of teaching computer science that is taught by a person or group of persons who have the appropriate expertise.

b. Courses on programming applications in both Pascal and BASIC, with emphasis on programming proficiency in both languages. At least one course should include exposure to, and preferably experience in, the computer language LOGO.

c. A required component of five courses that includes:

(1) Introduction to Programming and Algorithm Design, including programming using a high-level language;

(2) Computers and Education, including analysis of the major instructional uses of computers;

(3) Computers and Society;

(4) Programming Languages, including the definition and structure of languages and comparison of existing high-level languages.

(5) A choice of either Introduction to Computer Systems or Microcomputer Systems and Applications.

d. Due to its inclusion in all five current state programs reviewed, serious consideration should be given to

requiring a course called Advanced Topics in Programming and Algorithm Design and Analysis, using a high-level language.

e. A group of elective courses which includes

(1) Advanced Topics in Programming and Algorithm Design and Analysis (if it is not required);

(2) Computer Assisted Instruction;

(3) Introduction to File Processing;

(4) Data Structures;

(5) Fundamentals of Computer Organization and Digital Logic;

(6) Assembly Language Programming.

APPENDIX A

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APPENDIX B

SAMPLE LETTER OF TRANSMITTAL TO STATE CERTIFICATION OFFICERS

November 15, 1982

Department of Computer Sciences
North Texas State University
P.O. Box 13886
Denton, Texas 76203-3886

Dear

I am currently conducting research for my doctoral dissertation at North Texas State University. As part of this research, I am attempting to determine each state's current regulations concerning the certification of high school computer science teachers. I am mailing this questionnaire and request for information to the chief certification officer in each of the fifty states. Will you please take a few moments of your time to complete the questionnaire and return it to me by December 15? Your response will be crucial to the study. Unless the current situation in all 50 states can be determined, an accurate description of the national status of computer science certification cannot be developed.

A stamped, self-addressed envelope is enclosed for your convenience in returning the completed form. If you are interested in receiving a summary copy of the report when it is completed, please write your name and address on the enclosed post card and mail it separately. I welcome any additional comments or questions that you might have. I can be reached by telephone at 504-388-1495.

Yours truly,

Harriet G. Taylor

Enclosures

APPENDIX C

SAMPLE FOLLOW UP LETTER TO STATE CERTIFICATION OFFICERS

Dear

Several weeks ago, I sent you a questionnaire about the certification of computer science teachers. I have not yet received a response from your state.

The responses so far have been very positive and informative. However, a true picture of the national status of computer science certification cannot be drawn without a response from your state.

Would you please take a few moments to complete the questionnaire and return it to me in the enclosed envelope? I have enclosed a second copy of the questionnaire for your convenience as well as a post card to fill out if you would like a copy of the report.

Again thank you for your cooperation and valuable contribution to this research effort.

Sincerely,

Harriet G. Taylor

HGT/bss

Enclosures

APPENDIX D

SAMPLE INSTRUMENT FOR SURVEY OF STATE OFFICERS

NATIONAL COMPUTER SCIENCE CERTIFICATION SURVEY

1. Demographic Information

   Your state _____

   Name and title of the chief certification officer in your state:

   Name_____

   Title_____

   Name, address, and phone number of person to be contacted if additional information is needed

   Name_____

   Address_____

   _____

   _____

   Phone _____

2. Circle the one item below that best describes your state's current regulations concerning the certification of computer science teachers.

   a. This state offers certification in computer science apart from any other subject area.
   (Now answer question 4 on the back of this page)

   b. This state offers certification in computer science as a related part of another discipline.
   (Now answer question 3)

   c. This state currently has no provisions for the certification of computer science teachers.
   (No further information is needed)

3. Please describe the certification requirements for the related discipline which encompasses computer science. Point out any special requirements that pertain only to computer science.

4. Answer this group of questions only if your response to question 2 was a!

   a. Please supply the name of one college or university in your state that now offers a state-approved program leading to certification in computer science, which is representative of all the programs in your state.

   b. Approximately how many certified computer science teachers are there in your state?

   c. When computer science certification requirements were adopted, what provisions were made to certify those teachers who were already teaching computer science but did not meet the requirements for certification?

   d. How can a teacher already certified in your state in an area of specialization other than computer science become certified in computer science as well?

   e. Would you please either describe the requirements for computer science certification or enclose a brochure giving this information?

APPENDIX E

SAMPLE LETTER OF TRANSMITTAL TO LEADERS IN THE FIELD

Dear

Harriet Taylor, a doctoral candidate, and I are engaged in a study of the certification of high school computer science teachers. Through this study, we hope to determine if computer science is a subject field of sufficient importance that certification of computer science teachers should be instituted nationally. In addition, we want to determine the computer science content most appropriate for programs to train computer science teachers.

As part of this research, we are mailing the enclosed survey form to a group of leaders in the field of computer science education. Would you please take a few moments of your time to complete the survey and return it by December 15th. Your response will be a crucial and valuable aspect of this research study. You need not identify yourself on the form. Individual responses will be held in confidence.

A stamped, self-addressed envelope is enclosed for your convenience in returning the completed survey. If you are interested in receiving a summary copy of this report, please write your name and address on the enclosed post card and mail it separately.

Thank you for your cooperation and participation in this project.

Sincerely,

Jim Poirot, Chairman
Department of Computer Sciences

JP:sd

enclosures

APPENDIX F

SAMPLE FOLLOW UP LETTER TO LEADERS IN THE FIELD

Dear

Several weeks ago, Harriet Taylor, a doctoral candidate, and I sent you a survey form about computer science education. So far, we have not yet received a form back from you.

The responses have been very positive and informative. However, as many responses as possible are needed to draw a true picture of the nature of computer science education.

Would you please take a few moments to complete the survey and return it in the enclosed envelope? Another copy of the survey form is enclosed as well as a post card for you to fill out if you would like a copy of the report.

Again, thank you for your cooperation and valuable contribution to this research effort.

Sincerely,

Jim Poirot, Chairman
Department of Computer Sciences

JP/bss

Enclosures

APPENDIX G

SAMPLE INSTRUMENT FOR SURVEY OF LEADERS IN THE FIELD

SURVEY ON THE NATURE OF COMPUTER SCIENCE EDUCATION AND CONTENT OF TEACHER TRAINING PROGRAMS

A. GENERAL ISSUES IN COMPUTER SCIENCE EDUCATION

Please circle the appropriate number that represents your opinion. Use the scale below for your reference.

very strongly agree	agree	no opinion	disagree	very strongly disagree
1	2	3	4	5

1.	Computer science is a distinct discipline not a part of any other subject.	1	2	3	4	5
2.	Basic computer literacy should be required of all high school graduates.	1	2	3	4	5
3.	There are enough full time positions for teachers of computer science, that a computer science teacher will not need certification in another area of specialization to be employed.	1	2	3	4	5
4.	Most administrators support the introduction of computer science into the high school curriculum.	1	2	3	4	5
5.	Certification of computer science teachers is a national problem that demands immediate attention.	1	2	3	4	5
6.	By 1990, the first year computer science courses now being taught in most colleges and universities will be taught in high school.	1	2	3	4	5
7.	Cost of computer hardware is no longer a major deterrent to the introduction of computer science into the high school curriculum.	1	2	3	4	5
8.	More indepth training is needed for a teacher who will teach about computers than one who simply uses computers in the classroom.	1	2	3	4	5
9.	In the near future, most high schools will form computer science departments.	1	2	3	4	5

10.	Computer literacy is the next great crisis facing American education.	1	2	3	4	5
11.	Most parents feel that computer education should be part of their child's general education.	1	2	3	4	5
12.	Colleges and universities must act quickly to develop computer education programs to train prospective teachers of computer science.	1	2	3	4	5
13.	Teachers of computer science should be certified in the area of computer science and not in another subject field which encompasses computer science.	1	2	3	4	5
14.	There is a definite downward movement of the computer science curriculum now found in colleges and universities into the high school.	1	2	3	4	5
15.	A major barrier to the implementation of high school computer science courses is the lack of a supply of adequately trained teachers.	1	2	3	4	5
16.	Credit for a high school computer science course should be given as a unit of computer science and not a unit of math, science, or business.	1	2	3	4	5
17.	Most teachers feel that computer science should be included in the general education of all students.	1	2	3	4	5
18.	There are now many programs in this nation designed to train computer science teachers.	1	2	3	4	5

19. Please list any additional comments or insights that you have about the general nature of computer science education.

B. COMPUTER SCIENCE COURSES MOST APPROPRIATE FOR A PROGRAM TO TRAIN COMPUTER SCIENCE TEACHERS

DIRECTIONS FOR THIS SECTION

a. Please select from the list of courses on the next page, a maximum of 6 courses that should be part of a core group of required courses for teachers of high school computer science. Place an "R" in the space to the left of the course title to designate these courses.

b. Select, by placing an "E" in the space to the left of the title, a maximum of six courses that would form an elective group.

c. In no case should you select more than 12 courses. If you feel that a course other than those listed would be more appropriate, write in the course, including a brief description, at the end of this section.

d. In most of the programs examined, a course in the materials and methods of teaching computer science was found. In some programs, the course was part of the professional education component and in others it was a computer science course. Due to the conflict about the proper place for this course, it is not included in the list of courses. Please express your opinion about the appropriateness of such a course and its proper place in the curriculum in the space below.

PLACE AN "R" BY A MAXIMUM OF SIX REQUIRED COURSES
PLACE AN "E" BY A MAXIMUM OF SIX ELECTIVE COURSES

_____1. Introduction to Programming and Algorithm Design, including programming using a high level language

_____2. Advanced Topics in Programming and Algorithm Design and Analysis, using a high level language

_____3. Introduction to Computer Systems

_____4. Assembly Language Programming

_____5. Fundamentals of Computer Organization and Digital Logic

_____6. Introduction to File Processing

_____7. Operating Systems

_____8. Data Structures

_____9. Programming Languages, including definition and structure of languages and comparison of existing high level language

_____10. Computers and Society

_____11. Computers and Education, including analysis of the major instructional uses of computers

_____12. Computer Assisted Instruction, survey, evaluation, and design of CAI

_____13. Minicomputer Systems

_____14. Microcomputer Systems and Applications

_____15. Numerical Methods

_____16. Database Management Systems

_____17. Artificial Intelligence

_____18. Software Engineering

_____19. Computer Graphics

_____20. Compiler Design and Construction

_____21. Systems Programming

_____22. Theory and Design of Programming Languages

_____23. Simulation and Modelling

_____24. Advanced Computer Organization and Computer Architecture

25. Please list below any courses other than the 24 courses in the above list, that should be included in the required group, still restricting the total number of required courses to a maximum of 6.

26. Please list below any courses not included in the 24 courses already listed that should be part of an elective group, still restricting the total number of elective courses to a maximum of 6.

C. IDENTIFICATION OF HIGH LEVEL LANGUAGES A TEACHER SHOULD EXHIBIT PROFICIENCY IN

Select from the list of languages below those that you feel a high school teacher must be proficient in. Designate your choices by placing an X to the side of the item. Please limit your selections to a maximum of 3 of the languages. (You may choose less than 3).

_____1. ADA

_____2. BASIC

_____3. COBOL

_____4. FORTRAN

_____5. LISP

_____6. PASCAL

_____7. PL/I

_____8. SNOBOL

List below any languages not included in the above list that would be more appropriate, still restricting the maximum number of languages to 3.

D. COMMENTS

Please list below any other comments that you would care to make.

Thank you for your assistance in this project!

APPENDIX H

NOTES ABOUT STATES NOT OFFERING SEPARATE COMPUPTER SCIENCE CERTIFICATION

California

Computer science is not one of the sixteen single subject areas for which regular credentials are issued in California. Computer science courses are usually taught under the math or industrial arts classification.

Under statutes enacted in 1979, an individual can add a supplementary authorization to an existing credential on the basis of twenty semester hours of undergraduate course work in the specific subject or ten hours of upper level or graduate work. Computer Concepts and Applications is one of the supplementary subjects that can be added to an existing single subject credential. Therefore, a teacher holding credentials in areas other than math or industrial arts could be authorized to teach computing courses through this provision.

Some aspects of computing could be taught as vocational subjects. These courses could be taught by someone holding a designed subjects teaching credential due to work experience in the area. For such credentials, an individual must possess a high school diploma or have passed an equivalency test and have adequate, successful, and recent

experience in the vocational area named with a minimum of five years experience. One year of the experience must have been within the three-year period immediately preceding the period in which the credential is issued.

California does not, therefore, have any provisions for regular certification in computer science. A fully certified high school teacher in California would have to achieve certification initially in one of the sixteen subject areas. If the area of certification was anything other than math or industrial arts, single subject authorization would have to be obtained to teach computer science courses.

Colorado

In Colorado, math teachers must have some exposure to computer science as a part of their training program.

Delaware

Delaware plans to establish computer science certification soon. At the present, computer science is usually taught by teachers certified in secondary math or business education. However, a person holding any certification and proper competencies is judged by the state to be qualified to teach computer science.

Florida

In Florida, the two academic computing courses, Computer Mathematics I and II, can be taught by teachers holding math certification. All other computing courses are classified as vocational subjects and are part of the data processing occupation curriculum.

Teachers in this curriculum must be certified in either business education, which is an academic certification achieved through completion of an approved college program, or business-data processing or vocational-technical electronics. Both the business-data processing and vocational-technical electronics certifications are based on work experience. Applicants for such certification must have been employed after reaching the age of sixteen for six years full-time. At least two years of the employment period must have been in a job slot at an appropriate level of experience for such a teacher.

All computer programming courses are taught in the data processing occupation curricula. Programming courses can only be taught by a person holding a business education certificate or a person with vocational-technical electronics certification with a minimum of two years in a job position of programmer or higher.

Kansas

Computer science certification in Kansas is considered to fall under the state-approved programs in business data processing. Kansas is in the process of drafting standards for a program in Computer Studies. Such a program would be designated to train individuals to teach computer literacy, including programming.

Kentucky

Kentucky does not have certification per se for computer science teachers. The state has identified certain courses that can be offered in Kentucky public schools and designated according to certification areas which teachers can teach these courses. Among these courses are Introduction to Computers, which can be taught by holders of certain types of business certification or math certification, and Data Processing I and II, which can be taught by teachers holding designated types of business credentials. An endorsement for teaching advanced data processing may be added to a high school certificate with a major in basic business or general business upon the completion of nine semester hours of data processing.

Louisiana

Louisiana has no form of certification for computer science teachers. All teachers with secondary math certification are approved, but not certified, to teach computer science.

Massachusetts

In Massachusetts, the only teachers eligible to teach computer science are those holding mathematics or science certification. Massachusetts certification standards are stated in competency terms. One of the stated competencies for the mathematics teacher is the knowledge of computer mathematics. A competency for most of the natural sciences is the knowledge of the relationships among the sciences and between the sciences and other fields of knowledge. Computer literacy could be considered a related necessity for most certificates under these circumstances. When hiring a computer science teacher, it would be the duty of the individual school system to evaluate the candidate in terms of competencies. In addition to the competencies, the individual would also need to hold math or science certification.

Missouri

Teachers in Missouri are approved to teach computer science courses who have either a math or business education certificate and at least five semester hours in computer science.

New Jersey

New Jersey does not offer certification in computer science. Anyone holding a regular New Jersey instructional certificate may qualify for an endorsement as a teacher of data processing by completing a twelve-hour specialization program, six hours of which are in data processing. Six colleges or universities in the state offer approved teacher preparation programs for this endorsement.

Such an endorsement authorizes the holder to teach data processing in all public schools in New Jersey. Data processing in New Jersey normally includes the areas of keypunching, unit record operation, computer operation, programming, and technology.

North Carolina

North Carolina is planning to establish computer science certification.

North Dakota

In North Dakota, teachers with either mathematics or science as a major or minor area of certification can teach computer science courses.

Ohio

In Ohio, certification requirements will be undergoing revision in the near future. Computer science is being looked at closely.

A teacher holding any type of certificate may receive a standard special teaching certificate with data processing as the area of specialization. The requirement for such a validation is the completion of six semester hours or nine quarter hours of data processing. Many colleges and universities in the state of Ohio offer a standard block of courses leading to such an endorsement. Most computer-related courses in Ohio are taught in the data processing curriculum, including programming courses using several languages.

Oklahoma

The (Blue Book) Administrator's Handbook for Elementary, Middle, Junior High and High School contains the regulations concerning teachers of Computer Programming/Computer Science. According to the handbook, a teacher of such courses must have eighteen hours in business education,

mathematics, or science with at least six hours of computer training.

Oregon

A teacher holding a certification endorsement in mathematics is, by rule, qualified to teach computer science in Oregon.

Pennsylvania

Pennsylvania does not offer certification in computer science as a teaching field. According to state guidelines, the School Program Specialist Certificate is issued for specialized professional service when no such service is reserved for another category of certification. This certification may be used to provide for the teacher an "academic computer science" course in the general academic curriculum.

A person with Pennsylvania certification in any area may be issued the School Program Specialist Certificate to teach a course titled academic computer science or computer literacy. The technical eligibility criteria for the certificate are established by the local school authority depending on the availability of local expertise and specialty training.

Vocational education in Pennsylvania is responsible for developing occupational skills in business data processing,

scientific data processing and electronic computer composition. Most aspects of developing employment-level operational computer competency except for electronic composition are also reserved for the business education data processing curriculum. Persons instructing courses in either curriculum would need appropriate business or vocational certification.

Rhode Island

Computer science teachers in Rhode Island must be certified in the area in which computer science is taught within the school. For example, math certification would be needed if the course was taught by the mathematics department and business certification required if taught by the business department.

South Dakota

South Dakota has no certification endorsement in computer science as an academic area. However, for school accreditation purposes, state regulations have been adopted to define who is allowed to teach computer science. The regulation, which is effective July 1, 1983, provides that a teacher instructing a course in computer programming or hardware that lasts nine weeks or longer must have a minimum of eight semester hours in computer-related courses. At least four of the hours must be in programming language and

two in the fundamentals of computer systems. Those teachers employed and assigned before the effective date to teach such courses must have a minimum of four semester hours of computer-related courses. The teacher would also be required to hold a basic teaching certificate in some other area and would be considered to be teaching a course outside the major area of specialization.

Utah

In Utah, computer science is currently part of a composite teaching major (math, computer science, statistics), but approval is pending for a free-standing teaching minor in computer science.

Virginia

In Virginia, computing courses are taught by business teachers in the data processing block within the business curriculum. The teachers certified to teach in this area are those who have certification in business education-data processing.

Washington

Washington is contemplating such endorsements for teaching certificates.

APPENDIX I

SELECTED STATE-APPROVED COMPUTER SCIENCE EDUCATION PROGRAMS

THE UNIVERSITY OF ARIZONA

REQUIREMENTS:

Eighteen units are required for a teaching minor. These courses consist of numbers 115, 227, 237, 327, 342, and one 400-level course.

COURSE DESCRIPTIONS:

115. Computer Science Principles (3) I,II. Algorithms, programs and computers. Problem analysis and structured program design in a high-level language. Machine and systems organization, data representation, program testing and verification. Prerequisite: Mathematics 116.

227. Program Design and Development (3) I,II. Introduction to programming using a high-level language such as Pascal. Several medium size projects will be required, with emphasis placed on the process of program design using stepwise development. Prerequisite: Course 115.

237. Introduction to Assembly Language Programming (3) I,I. Introduction to digital computers. Elementary hardware concepts. Machine operations and instructions. Assembly language concepts. Programming in assembly language. Prerequisite: Course 115 or 122.

327. Comparative Programming Languages (3) I,II. Introduction to several major high-level programming languages. Characteristics of programming languages. Programming projects are required in at least four languages. Prerequisite: Course 121, 122, or 123.

342 Data Structures (3) I,II. Mathematical preliminaries; fundamental data structures and associated algorithms; implementations and applications; stacks, queues, trees, graphs, sorting and searching. CR 327, Prerequisite: Mathematics 362.

Source: Department of Secondary Education, The University of Arizona

ILLINOIS INSTITUTE OF TECHNOLOGY

REQUIREMENTS:

The MST (Master of Science for Teachers) is designed for and open only to certified teachers with a minimum of three years teaching experience. Students not having training that includes CS 350, 460, and 461, or their equivalent must make up the deficiency before graduation. The degree program requires 32 credit hours with no more than 12 hours of 400-level courses. The program is divided into three components. The first component, core courses, is a fifteen hour block made up of CS 440, 485, 560, 561, and 565 or 566. The other two components are a twelve hour elective component and a five credit hour project.

COURSE DESCRIPTIONS:

CS 440 Programming Languages and Translators I. (3hr)

CS 485 Computers and Society. (3 hr)

CS 560 Computer Science in the Classroom. (3 hr) Emphasis will be placed on the commonly used computer languages and their use in the classroom. Discussion of how as well as what to teach in a secondary school computer science course. Prerequisite: CS 350.

CS 561 The Computer and Curriculum. (3 hr) Preparation and organization of computer-based instructional units in light of current materials available. Emphasis on incorporating the computer into secondary school curricula. Prerequisite: CS 350.

CS 565 Computer-Assisted Instruction (3 hr) Devices and techniques for the effective use of the computer in an educational environment. CAI (Computer Assisted/Aided Instruction) being one of the major areas of investigation. Prerequisite: CS 560 or 561.

CS 566 Practicum in the Application of Computers to Education. (3 hr) Provides supervised experience in the development of computer-based teaching units in disciplines other than computer science or data processing. Evaluation of different theoretical and/or technical approaches to use of computer in the classroom. Prerequisite: CS 560 or 561.

BOWLING GREEN STATE UNIVERSITY

REQUIREMENTS:

Thirty hours of computer science coursework; including CS 101 or 103, CS 201, 202, 205, 305, 306, 307, and nine hours of electives, six at the 400-level, are required for a computer science teaching major. Twenty-one hours, including CS 101 or 103, CS 201, CS 205, and 12 hours of computer science electives are needed for a teaching minor in computer science. CS 100, 180, 260, 390, and 490 may not be applied to the major or minor requirement.

COURSE DESCRIPTIONS:

CS 101 Introduction to Programming. (3 hr) I,II,summer. Algorithms; programming in FORTRAN; introduction to computer organization; structures programming techniques. Several programming assignments required. For students without extensive programming experience. Not open to students with credit for another CS or MIS course. Prerequisite: two years of high school algebra or MATH 095 or 096.

CS 103 FORTRAN Programming. (3 hr) I,II,summer. FORTRAN for students with extensive programming experience. Algorithms; structured programming techniques. Several programming assignments required. Prerequisite: prior programming experience in any computer language. Not open to students with credit for CS 101.

CS 201 Assembler Language Programming (3 hr) I,summer. Basic computer organization; data representations; addressing techniques; subroutines and macros. IBM 370 assembler language. Prerequisite: Grade of "C" or better in CS 101 or CS 103.

CS 205 Advanced Programming Techniques (3 hr) I,II. Programming in PASCAL. File processing, including sequential and random files. Recursion. Large program development. Linked lists using arrays. Interactive text editing and utility routines. Prerequisite: Grade of "C" or better in CS 101 or 103.

CS 305 Data Structures. (3 hr) I. Implementation and applications of commonly used data structures, including stacks, queues, trees, and linked lists. Storage allocation anad collection; hashing techniques; searching and sorting. Use of PASCAL language, including pointer variables. Prerequisite: CS 201 and 205.

CS 306 Programming Languages. (3 hr) II. BNF description of programming languages. Significant features of existing programming languages. Structure and comparison of languages for numeric and nonnumeric computation. Languages studied typically include PL/1, SNOBOL, and APL. Prerequisite: CS 205.

CS 307 Computer Organization. (3 hr) II. Components of digital computer hardware: flip-flops, registers, adders, memory devices. Computer system organization: control structure, addressing, interrupts, I/O. Prerequisite: CS 201.

Source: Department of Educational Curriculum and Instruction; Bowling State Green University

NORTH TEXAS STATE UNIVERSITY

REQUIREMENTS:

A minimum requirement of 27 hours of computer science coursework is required for a first teaching field. These courses consist of Computer Sciences 110, 111, 310, 410 and 15 hours of Computer Science electives, at least 9 of which must be advanced.

A second teaching field requires Computer Sciences 110, 111, 310, 410 and 12 hours of Computer Science electives, at least 6 of which must be advanced.

COURSE DESCRIPTIONS:

110. Introduction to Computer Science. (3 hr) A basic course covering logical operation and organization of a digital computer, development of basic algorithms, number systems, boolean algebra, flowcharting techniques and programming in the BASIC computer language. Recommended as first course for computer sciences major. Prerequisite: 2 years high school algebra or geometry, or 3 hours methematics.

111. Program Development. (3 hr) Problem solving techniques; algorithmic processes; top down design; structured programming in a high level language. Prerequisite: Computer Science 110.

310. Computer Systems Analysis. (3 hr) Principles of computer systems analysis and design; system hardware and software characteristics. Comparison of existing computer facililties. Prerequisite: 6 semester hours of computer programming, in 2 languages.

410. Computer Science for the Teacher. (3 hr) An introduction to computers in education. A survey of computer topics covered in introductory and secondary school course. Motivation and objectives in computer education; some programming in the BASIC computer language. Survey of instructional uses of the computer. Not to be counted toward Computer Sciences major (may be counted as elective) unless computer science is to be a teaching field.

Source: Department of Computer Sciences, North Texas State University.

UNIVERSITY OF WISCONSIN - GREEN BAY

REQUIREMENTS:

A minimum of 25 semester hours are required for a teaching minor with mathematics-computer science emphasis. This minor leads to certification to teach computer science in grades 7-12. This teaching minor is taken in conjunction with an appropriately related teaching major. The methods course in mathematics and student teaching in computer science and/or mathematics are required.

Twenty-five hours, including MATH 202, MATH 203, MATH 255, MATH 256, MATH 257, MATH 320, MATH 351, and MATH 353. Seven other courses may be elected.

COURSE DESCRIPTIONS:

MATH 202 Calculus and Analytic Geometry I. (4 cr.) Differential and integral calculus of the elementary functions with associated analytic geometry; applications. Prerequisite: 600-104 or satisfactory placement score. (See note on credit in 600-201.)

MATH 203 Calculus and Analytic Geometry II. (4 cr.) Transcendental functions; techniques of integration; applications sequences and series. Prerequisite: 600-202.

MATH 255 FORTRAN: A Scientific Programming Language. (2 cr.) A thorough introduction to FORTRAN programming and the design of elementary algorithms. Includes integer, real number, and alphanumeric processing: one, two, and three dimensional arrays; FORMATS; functions; subprograms. Prerequisite: 600-202.

MATH 256 Introduction to Computer Science I. (3 cr.) This course is designed to develop an understanding of the basic concepts of Computer Science. Topics include problems solving, algorithmic processes, characteristics and organization of computers, and programming in a higher level language using techniques of good programming style. The assignments include a large number of applications in the physical, social, life, and management sciences.

MATH 257 Introduction to Computer Science II. (3 cr.) This course continues the development of discipline in the program design, style and expression, as well as debugging and testing begun in 600-256. Students are introduced to large programming projects covering such topics as aspects of string processing, recursion, internal search/sort methods, simple data structures, machine organization, and assembly language, Algorithm analysis, documentation, use of subroutines and other techniques used in advanced programming projects are also studied.

MATH 320 Linear Algebra I. (3 cr.) Matrices and vector space concepts. Systems of linear equations, matrices, determinants, vectors in 2- and 3-space, vector spaces, linear transformations, eigenvalues, and eigenvectors. Prerequisite: 600-202.

MATH 351 Data Structures, Storage and Retrieval. (3 cr.) An introduction to concepts involved in storage, retrieval, and processing of data for use in computer applications. Included are structures such as arrays, stacks, queues, linked lists, trees, and networks. Particular emphasis is placed on design of efficient algorithms that use these different structures for various processing needs. These include searching, sorting, evaluation of arithmetic expressions, construction of symbol tables, and memory management. Prerequisite: 600-251.

MATH 353 Computer Organization and Programming. (3 cr.) An introduction to binary, octal, and hexadecimal number systems, and conversions from one system to another. Data representation and computer arithmetic procedures. A thorough study of MIX assembly language programming, including actual programming exercises. Also included is an overview of computer software and hardware components and their roles in a complex computer system. Topics considered are assemblers, loaders, compilrs, memory, microprogramming, monitoring, gates, adders, circuits, and applications of Boolean algebra to circuit analysis. Prerequisite: 600-251 and a background in algebra.

EDUC 313 Secondary School Teaching Methods in Mathematics. (3 cr.) For students who wish to be licensed to teach mathematics in Wisconsin secondary schools. Prerequisite: Junior standing and appropriate preparation in mathematics.

EDUC 403 Student Teaching in the Secondary School. (4-12 cr.) Supervised student teaching or internships in the secondary school. Required for a teacher's license. Prerequisite: Senior standing, preregistration with faculty in Education, written cons inst, and assignment by the faculty in Education. Offered on a pass-no credit basis only.

Source: Department of Education, University of Wisconsin, Green Bay.

APPENDIX J

COMMENTS MADE BY LEADERS IN THE FIELD ABOUT THE GENERAL NATURE OF COMPUTER SCIENCE EDUCATION

Computer science courses (advanced programming) should be used as a foreign language credit at the high school.

1. Will be trouble with a separate department because of "Turf".
2. Great lack of state leadership.
3. Colleges will drag their feet - we have been teaching computers for 17 years in high school.

A good course in discrete math would be much better than a lousy course in calculus.

Computer literacy is not part of computer science but part of computer education.

There is too much difference between small schools and the larger ones. Small schools have 1-2 computers with an inexperienced teacher. We have 20 Apple computers and teach Pascal, Fortran and assembler. (No BASIC at all! - BASIC is fine for computer literacy, not for computer science.)

Problems: 1) Who will teach the teachers?
2) Education majors and computer science majors competing for grades in the same class is a lousy idea - what to do?
3) Politics: What old high school courses must give way to make room for the computer science courses?

We must get going on it soon.

1) The computer science program will lend to business and industry "knowledge worker" preparation rather than Ph.D programs in computer science. Hence should have different goals.
2) The rapid change in the computer field will make pre-college courses different than traditional programs. Pre-college programs will have to be "competitive" with university programs for skills, knowledge, and timeliness of information. Trickle down courses won't work. Institutes will be required yearly and computer networks for daily access will be a "must."

3) The introduction of computer science programs will "increase" the shortage of teachers for the short run. Like the teacher institutes of the 60's, teachers with computer skills will quickly move on to jobs in industry and community colleges.

No general agreement on title "Computer Science." It means differently to schools and industry. We prefer the term "Information Systems" for broad scope and computer science for technical concepts (systems programming, simulation, operating systems, etc.)

How about using "computer and information science" in place of the term "computer science"?

Special consideration in certification to job experience needs to be required, so those computer teachers can approach the field from both theory and applications so both can be passed on to the students.

Though computer education is a major area of concern at the high school level, there are many others, curricular and non-curricular. For the foreseeable future, money will remain the key. Even though the cost of computers is low, many schools do not have adequate libraries and so forth, and these situations must be corrected. Quite frankly, I am happy I don't have to be the one to decide what to do and what not to do.

A more appropriate category would be "I don't know" on many questions.

Colleges haven't learned to separate computer science from math yet! So high schools won't for a long time. Therefore, combine it with all other subjects meanwhile. Eventualy, some courses will be eliminated and move to high schools as was the case with math.

A major issue is supply/demand vis-a-vis salaries - ideally, strong training is desired for teachers. But, when strong training leads to exiting from teaching then resources are misdirected.

I believe certification is appropriate but as a minor, not a major field at the pre-college level. Teachers need to be more broadly qualified.

Without good development in our schools, kids will have only the junk-like BASIC that they pick up at Computerland!

Question: What part will the College Board AP exam play in the high school computer science courses in the future?

I see a trend in secondary schools back to math and reading skills. State universities are going to demand better-prepared students. There may not be much time to give to computer science, especially in rural schools. The computer science job situation is destined for a correction within 10 years. There will be emphasis on theoretical computer science. Secondary schools may teach programming!

APPENDIX K

COURSES WRITTEN IN BY LEADERS IN THE FIELD

Required Courses

Problem Solving and How to Teach

A course in how to teach programming (what to stress, structure and documentation versus non, what languages when, how to best explain certain concepts, etc. Just because you can program does not mean you can teach someone else to.)

A preliminary course in problem solving methods and approaches. Many people can't program because they can't define a problem. They have no basis from which to choose a method of attack.

Computer Literacy

Evaluating Computer Materials

Twelves hours +/- of an applications directed sequence to study specific problem areas and techniques related to computers.

At least 3 hours of technical writing/documentation training.

Discrete mathematics.

Analysis of Algorithms

Elective Courses

A course on using microcomputer software (i.e. word processing, visicalc, etc.)

Data communications

Word processing for the classroom

Secondary Education Computer Applications

Functional Programming Languages

Finite State Machines, NP - Completeness, Recursive Function Theory

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