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A study of the factors which influences computer adoption by community college faculty in Virginia

Larry Joe Scott
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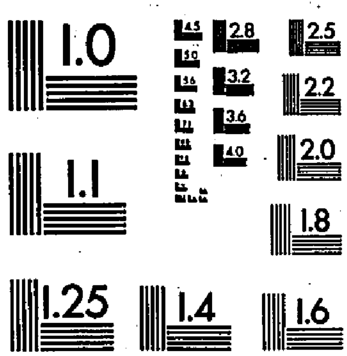

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A STUDY OF THE FACTORS WHICH INFLUENCE COMPUTER ADOPTION BY COMMUNITY COLLEGE FACULTY IN VIRGINIA

The College of William and Mary in Virginia ED.D. 1986

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A STUDY OF THE FACTORS WHICH INFLUENCE
COMPUTER ADOPTION BY COMMUNITY
COLLEGE FACULTY IN VIRGINIA

A Dissertation

Presented to

The Faculty of the School of Education

The College of William and Mary in Virginia

In Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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by

Larry Joe Scott

June, 1986

A STUDY OF THE FACTORS WHICH INFLUENCE

COMPUTER ADOPTION BY COMMUNITY

COLLEGE FACULTY IN VIRGINIA

by

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CHAPTER I

INTRODUCTION

Computers have been used to assist in course instruction since the mid-1960's. There are many uses for the computer such as providing self paced tutorial instruction, allowing for drill and practise in many subjects, calculating the statistical results of problems and experiments and simulating the effects of phenomena whose concepts are difficult to teach in a lecture setting (Bork, 1978). In general, studies have shown that student learning is enhanced by computers. Edwards and associates (1975) reviewed many research articles on computer use and student learning. In every case where computers were used as a supplement to normal instruction, student achievement was increased. When computers were used as a substitute for normal instruction, the results were mixed: three studies out of eight in a college setting showed an increase in student achievement. All studies reviewed by Edwards indicated that it took less time for students to learn course material if they used computers and two studies indicated that computers were more effective in enhancing learning among lower ability students. Kulik and associates (1978) performed a meta-analysis of 59 studies on computer-based college teaching and they concluded that computers had only a "modest" effect on college teaching but test scores were better in the computer user group and they learned the material in less time. Kulik and associates lumped all of the data on uses together and did not specify supplementary computer uses as separate from computers as the only method of instruction. Both Edwards and Kulik did find more effectiveness in elementary and secondary schools than at the college level. These studies did not separate community colleges from the rest of higher education but from these results, one could presume that community college students might profit more from computer use than students in four-year institutions. Community college students are often lower in ability, less prepared academically and more unsure of themselves than their cohorts in the rest of higher education. More supplemental material in any form plus the instructor's help is more important to community college students.

Aside from its effectiveness in enhancing learning, knowledge of computer use in general has become a vital issue in the late 20th century. As Andrews (1982) states "in the information/computer society where information is power and further differentiation between the rich and the poor hinges on information, there is a growing recognition of the importance of widespread public understanding of computers." Technology has brought the price of microcomputers well within the range of many households and the cost will probably continue to decline. Families are able to use microcomputers to calculate, to store information, to receive information over telephone lines, and, of course, to play video games. "Whatever a person needs to know and do with computers in order to function in our information-based society" is Martin and Heller's (1982) definition of "computer literacy" which has been referred to as "the next crisis in American education."

The term, computer literacy, is rapidly becoming the topic of the 80's. Journal articles and presentations at conference proceedings are rich with ideas on increasing the computer literacy of students from kindegarten through college. A few colleges are insisting upon computer literacy as a graduation requirement. Faculty computer literacy, strangely enough, is not discussed and researched as often, and the assumption seems to be that if faculty are given computer literacy courses, then computer usage is assured.

Several states or state agencies have begun to give impetus to instructional uses of the computer. In 1981, the Virginia Community College System published an extensive and detailed master plan for its computing services. Although the plan deals primarily with administrative and data processing/ computer science curricula uses, it does include a ten page section on other academic applications. This section on academic applications details the constraints, benefits, criteria, and goals for "academic computing" and acknowledges problems of faculty interest, costs (an important underlying factor in most of the considerations) and the availability and adequacy of hardware and software. The academic applications section concludes with the general guideline that "early attention and priority should be afforded proposals which are directed to areas most readily and widely susceptible to the uses and benefits of academic computing."

However, despite the importance of computers to modern society, the educational advantages of computers and the assumed faculty computer literacy, computers remain underutilized in education, especially in the college classroom. More public schools are responding by adopting computer innovations, thus more students are coming to college with some computer knowledge- either from the public schools or from home computers. Many of these students may find that their colleges are not as up-to-date with new technology as the students themselves. Students may begin to feel that they are being deprived of a fantastic technological resource that could aid their advancing education.

The opinion of many authors seems to be that "faculty development" will solve the computer use problem or that "technological determinism" will prevail. According to Anderson etal (1979), the latter concept proposes that if a technological innovation becomes available, then its use can be virtually assumed because of its efficiency and that society "allows a technique to become self-perpetuating eliminating human choice (p. 228)." Some might thus argue that computer innovations are becoming accepted so rapidly that its use is to be assumed and no research on prediction of adoption is necessary. However, Aslin and DeArman (1976) document many innovations in high schools that were never implemented or if implemented were quickly abandoned. Many of these innovations were technological in nature. Martellaro (1981) points out that teachers are often skeptical about innovations since they see them as the latest in a long line of innovations that have failed. One could also point to instructional television- no one can doubt the impact of television on modern society, but its use in education is still far from universal.

There are many factors other than those mentioned previously which may play a role in determining whether computers will be used instructionally or not. As King (1975) states in his review of research relating to computers in instruction - "it is anticipated that by identifying specific variables which have potential for impacting on student or instructor reactions toward CBI, the managers of computer based systems will be able to maximize the positive components and alleviate any negative factors" (p. 8).

King's review points to a common flaw in the literature - very little actual research on variables that affect instructional computer use and more "armchair writing." It is the premise of this study that there is a need for research on the relative importance of these variables. A study to determine which variables can best discriminate between computer users and nonusers can be very useful in policy decisions regarding computer implementation. Also, since computer technology is changing so rapidly, the importance of these variables may change over the years. This study can provide base line data for later replications in order to determine any change in the discriminating value of the variables, which will be valuable in revising guidelines for facilitating computer use.

The Problem and Research Questions

In order to research the variables which influence the instructional uses of the computer, the current status of computer use in community colleges must be ascertained. One must know how available the hardware is and how many faculty are making use of it. With this base line data available, the problem statement that presents itself is: What characteristics of the community college environment are the best discriminators between faculty who currently use computers in instruction and those who do not? These characteristics can be attributes of the individual community college faculty member or the environmental context under which the faculty member is working.

From this problem statement comes the general research questions which guide this study: (1) which of the environmental context variables are the best discriminators between community college faculty who use computers instructionally and those who do not, and are these variables better predictors than the individual faculty variables?; (2) which of the individual faculty variables are the best discriminators between community college faculty who use computers instructionally and those who do not, and are these variables better predictors than the environmental context variables? Under the heading of "environmental context" are a cluster of variables including perceived adequacy of computer facilities, presence of opinion leaders, level of administrative support, usefulness of the software, compatability of software with hardware, and opportunity to preview software. The "individual faculty member" heading also consists of a cluster of variables which include faculty attitude toward computers and toward innovations in general, faculty knowledge of computer logic, and faculty demographics such as sex, teaching experience, level of training with computers, experience with computer use, and tendency toward verbal or quantitative orientation.

An analysis of which variables within the clusters of variables are the most important discriminators can be of practical help to administrators if these attributes can be modified in a direction leading to greater computer adoption by faculty. Realistically, some of the attributes can not be altered but it would still be wiser for the administrator to understand the importance of certain attributes even if they could not be manipulated. Policy decisions would thus be much more effective if the predictive value of computer adoption variables were known. Peroit and Heidt (1982) were moving in the right direction when they introduced a questionnaire for educational computer leaders which measured needs, interests, and attitudes of faculty toward computers. Their questionnaire would allow administrators to understand the strengths and weaknesses within their faculty and could be used in planning effectively for educational computing. However, as with many other educational computing publications, the questionnaire was not field tested on a population or used in a case study, so its predictive effectiveness is not known. Also, their questionnaire measures only a limited number of variables and does not actually relate these variables to whether or not the faculty will end up using computers in their classes.

The community college setting was chosen for the study of this problem. The justification for this choice, as indicated earlier in this chapter, is based on research evidence that points to the assumption that community college students will benefit more from use of supplemental computer instruction than students in the remainder of higher education. Also, community college faculty are a more homogeneous group to study than 4-year college or university faculty. The latter group teach a wide range of courses from freshman through graduate level and many are more involved in research than teaching. Community college faculty, on the other hand, have little research involvement and teach a narrow range of courses at the freshman and sophomore level.

Theoretical Background

Computer usage is an instructional innovation whose implementation might partially depend on a school's administrative organization, but ultimately, is a factor of the decision of individual faculty members. These points must be incorporated into a theory which explains how institutions change in response to the introduction of an innovation. Of the four models of institutional change- conflict or political, organizational, planned change, diffusion- (Dill and Friedman, 1979) the most appropriate one for this study is the diffusion of innovations theory. The theory proposes that decisions on innovations are made as the information about the innovation is spread from its source through specific communication channels to the unit that will ultimately adopt or reject the innovation. This theory allows the "adopting unit" to be viewed as a college organization or as individual faculty members. Since this research involves an innovation in classroom teaching, the faculty member will be considered the adopting unit and the college administration as a change agent. Communication of Innovations by Rogers and Shoemaker (1971) serves as the classic text on diffusion theory. They discuss in detail, the major aspects of diffusion: attributes of the innovation, forms of communication, role of facilitators (opinion leaders and change agents), time factors (rates of adoption), and characteristics of the "social system" in which the adopting units operate. These aspects will be discussed in detail in the next chapter.

Sample and Data Gathering Procedures

The target population for the research was the full-time Virginia community college faculty employed in colleges which have implemented computer technology in the classroom. Within these schools, there are faculty who use computers instructionally and others who do not.

A stratified random sample of faculty at the appropriate colleges was asked to complete a questionnaire which was designed to measure: (1) aspects of computer knowledge (computer operation and computer logic); (2) attitudes toward computers and toward instructional innovations in general; (3) demographic information (sex, years of teaching experience, courses/workshops on computer uses, verbal versus quantitative orientation, ownership of a home computer); (4) faculty opinions on the presence of opinion leaders and change agents on campus; and (5) faculty opinions on the adequacy of the college's computer facilities. The variables measured by the questionnaire were used in a stepwise discriminant analysis to determine which variables were better discriminators of computer users versus nonusers. These variables would therefore be the best predictors as to whether faculty would use computers instructionally.

Limitations of the Study

This study was limited in its generalizability since it deals only with community college faculty and only in one state. Another limitation was that only one data gathering technique— the mail questionnaire— was used as the major source of data. Experimental manipulation of variables affecting computer adoption was not deemed to be feasible in terms of design, time, and finances. The nature of the information required did not lend itself to a strictly interview format since attitudes and knowledge are to be measured with a large population. The questionnaire depended upon self-reported data as well as subjective opinions which presented another limitation.

Definition of Terms

Several terms will be used throughout this report of the research and need to be precisely defined at this point.

An innovation is an idea or practise that is perceived as being new by the individual considering it for adoption.

Instructional computer use refers to any situation in which classroom instruction or evaluation is either assisted by or substituted with a computer program. Instructional use does not include data processing, word processing, and computer science courses since these areas specifically teach with and about computers.

Adopt is a term used in diffusion literature to denote a decision being made at some level of organization to implement and use an innovation. In this research, "adopting" will be considered a decision to use a computer instructionally as evidenced by previous or current use of the computer on more than three occasions in the past two years.

Adopting unit is a term which always has to be defined as the unit of analysis that is most appropriate to the innovation under study (Dill & Friedman, 1979). In this research, the adopting units are individual community college faculty.

Opinion leaders are individuals in a social system who are the first to know of an innovation and try to exert influence to cause others to either adopt or not adopt an innovation. Opinion leaders in this study are faculty members who attempt to influence the decision to adopt instructional computer use.

A change agent is a professional who is external to the system and who influences a decision in a direction desired by an organization (Rogers & Shoemaker, 1971). In higher education, this person might be a representative of some higher administrative level that seeks to cause a favorable decision about an innovation among faculty. Since they are considered "outsiders", change agents will use opinion leaders to accomplish their goals.

The social system is a collection of units which are "functionally differentiated and engaged in joint problem solving with respect to a common goal" (Rogers & Shoemaker, 1971, p. 28). The "adopting units" are subsets of the social system.

A mainframe computer is a large computer system capable of manipulating and storing millions of characters of information and can be accessed from a large number of terminals at remote locations. A mainframe computer is sometimes called a "minicomputer."

A microcomputer, in contrast, is a small computer with more limited memory (usually from 16000 to 128000 characters of information) and with an attached terminal and monitor screen. These are usually individual units in one location.

CHAPTER II

REVIEW OF THE LITERATURE

Theory and Rationale

Rogers and Shoemaker (1971) have the most detailed description of the diffusion theory but their emphasis is on agricultural and rural sociological examples. An excellent review of diffusion theory in education is provided by Dill and Friedman (1979).

The diffusion of innovations model explains change as occurring when an innovation enters, spreads throughout a system and a decision about that innovation is made by adopting units. Diffusion theory emphasizes who (sources) says what (message) to whom (receiver) through what channels (medium) and to what effect (consequence) (Conrad, 1978). Elements of the diffusion process include the characteristics of the innovation, and the attributes of members of the social system in which the innovation is introduced. Characteristics of the innovation (which will be elaborated later) are its relative advantage, compatability, complexity, trialability, and observability. Communication channels are interpersonal (probably most effective) or mass media (in higher education- journals, conferences, etc.). Time factors include the rate of adoption and whether knowledge of and adoption of the innovation is early or late. Attributes of members of the social system include location within the social structure, level of education (training), attitudes and values, degree of cosmopolitanism, and the effect of opinion leaders and change agents. Time factors and communication channels will not be used in this study which will concentrate on attributes of the innovation and characteristics of members of the social system.

Rogers and Shoemaker discuss the attributes of the innovation in a lengthy but general way. Martellaro (1981) has taken these attributes and applied them specifically to computer adoption. She discusses the relative advantage, observability, trialability, complexity, and compatability of computer use. Relative advantage means that faculty would perceive the computer to be a better supplementary means of teaching than current methods being used with a particular topic. The complexity of computers make some faculty feel that they could not understand and operate one. Observability is important because faculty must be able to see the effective results of teaching with a computer by observing a colleague's class. Here it would seem that the concept of an "opinion leader" who utilizes computers is very important. Martellaro spends most of her time discussing the attributes of compatability: how compatable is the computer to the facultys' values and experiences? Martellaro feels that some faculty are threatened by the computer and are afraid it will take away their jobs or, at least, dehumanize the education process. Some faculty have been disenchanted by the results of using past innovations and see the computer as just another innovation in a long list of failures. Martellaro's work, like that of many others is merely opinion based (probably from prior experience). Unfortunately these categories were never tested on a sample of faculty, but these very attributes may be predictors of whether community college faculty will use computers in their classrooms. As such, they will be utilized in the design of the faculty questionnaire in this study. Even through these attributes are of the computer innovation, the faculty are the ones who will designate their level of importance. As Dill and Friedman (1979) state, "the variables characterizing the innovation itself must be measured relative to each adopting unit; otherwise, there will be no variance" (p. 429).

Characteristics of the adopting units within the social system can be seen reflected in the research questions listed earlier- attitudes of faculty, education or training (faculty knowledge of computers), presence of opinion leaders or change agents, and position in the social structure (demographic characteristics of faculty).

Studies Related to Diffusion Theory

Four pertinent articles dealing with diffusion theory in higher education are by Kozma (1978), Evans (1967), Anderson and associates (1979), and Stern and associates (1976).

Kozma's line of research was to study the initiation of instructional innovation and follow its diffusion over several years (a longitudinal study). University of Michigan faculty were selected from those who applied for a workshop on using classroom innovations. These selected faculty were ones who were viewed as "opinion leaders" by their peers. After two years the participants showed a significant increase in the number of innovations used in their teaching. The applicants for the workshop that were not selected showed a moderate increase in use of innovations (which was not significant) but there was no increase among the general faculty (in other words, diffusion had not occurred). Kozma's research had some limitations, one being that perhaps two years is not long enough to observe diffusion occurring. Also he only measured the number of innovations used- a faculty member who dropped an innovation to pick up another would be counted as one who didn't innovate. Kozma's research did not examine any variable except the spread of the innovation and diffusion theory postulates many confounding variables as was discussed earlier. However, this study is one of the few that attempts to trace the diffusion of innovation through an institution.

Evans (1967) looked at faculty attitudes in a single time frame rather than following the course of diffusion. Evans studied the possible diffusion of instructional television (ITV) into a university by concentrating on the psychological attitudes of faculty toward ITV. He used Rogers and Shoemaker's characteristics of the adoptor and social system to explain the attitudes of faculty. Evans measured faculty attitudes using a modification of Osgood's Semantic Differential, followed by interviews. His research found that faculty in general were very self-assured about their instructional skills and felt that their present teaching methods were particularly suited to the courses they taught. Their image of themselves was of a professor lecturing in a small advanced class, using the blackboard, assigning homework and occasionally doing a demonstration. They ranked using ITV or other teaching machines near the bottom of their list of preferred methods. Evans found that faculty in general consider discipline knowledge as a sufficient criterion for faculty appointment but are not opposed to learning about other teaching methods. The image of faculty presented here seems consistent with the widely held view that faculty are quite conservative and tradition-oriented. In another section, Evans compares attitudes of extermely pro-ITV and extremely anti-ITV professors. As might be expected, anti-ITV faculty use the traditional approach to instruction, are more confident, are less likely to change, and any innovation that they adopt must fit into their "ordered world." The pro-ITV faculty tend to be less conservative, less tradition oriented, less self-assured, more eager to experiment, use more diverse student evaluations, and consider teaching methods to be more important than do their colleagues. For all of this pro and anti research, Evans admits that faculty are actually distributed along a continuum where attitudes become mixed and faculty that favor one innovation might oppose another. Evans seems to go overboard in "pigeonholing" groups of attitudes into two categories! No evidence was given to suggest that attitudes toward ITV (or computers) are actually related to attitudes about other items. Dill and Friedman (1979) point out that Evans was actually using a "precursor to actual adoption as the criterion variable." In other owrds, the faculty were not actually <u>adopting</u> ITV- their <u>attitudes</u> toward using ITV was what was measured. Evans' research, like that of Kozma, did not take into account many constructs from the diffusion theory. However, Evans' research does provide a stronger background for looking at factors involving faculty attitudes which will be important in this study.

Stern and associates (1976) studied the adoption of a computerized literature search service among Ohio State University faculty. They developed a profile of adopters and nonadopters using criteria of earliness and lateness of adoption, demographic variables, attitudes (from scales of cosmopolitanism and orientation to change), opinions regarding information sources for obtaining literature citations and relative centrality. Relative centrality refers to the individual's relative position in the peer group structure as determined by self reported numbers of faculty that the individual (1) discusses research problems with, (2) obtains information about new teaching methods from, (3) considers to be a personal friend and (4) considers to be very innovative. Interestingly, all variables except for time of adoption were measured before the information service was announced. Stern feels that gathering data only after adoption may create a bias in attitudes among the adopters since they are already "sold" on the innovation. Stern found that adopters placed greater value on professional journals and literature searches than nonadopters but there were no differences in attitude or demographic variables. The time of adoption (early versus late) had no significant relationship with any of the variables. Relative centrality measurements were significantly different between adopters and nonadopters. Adopters were more "central" in their social system since they gave significantly more peer names for all categories except for peers they considered innovative. Stern's results challenge several aspects of diffusion theory generally thought to be important but were not significant factors in his study- demographic variables, earliness or lateness of adoption, and attitudes. Stern admits, however, that his population was very homogeneous to begin with and the computer search service had a "high adoptive potential"- most faculty need literature searches anyway and the service was free. The relationship between centrality and adoption is predictable from diffusion theory which considers position in the social system and the effect of opinion leaders as important variables. Relative centrality could be an important variable affecting whether community college faculty will adopt computer uses.

Anderson and associates(1979) discuss two theories that could explain why secondary school teachers accept or reject instructional computing. One is the theory of technological determinism which proposes that if a technological innovation is readily available, it will be utilized. On the other extreme, lies several theories which propose that many cultural and sociological factors determine whether technology will be utilized. Rogers and Shoemaker's diffusion theory is given as one of these eclectic positions. In fact, Anderson seems to refer to diffusion theory extensively in defining the constructs that he will use to measure acceptance - rejection. The brief questionnaire, sent to all Minnesota secondary school math and science teachers, measured teacher attributes (attitudes toward new technology, amount of training with computers, age, sex, adequacy of computer training and number of years of teaching experience), features of the school/work setting (subject area, school size, grade range) and community characteristics (size, distance to technical resources). The researchers also asked the teachers to give the number of computer terminals available for students and whether the facilities were readily available for student use. Also, they were asked if they had used computers in their classes and if they were currently using them. The researchers found a strong relationship between current computer use and the number of available terminals and with the availability factor. They then performed a multiple regression analysis of current computer use on 13 independent variables (as listed previously) and an analysis of discontinued use on the 13 variables. Teachers indicating no computer use were dropped from analysis. In the computer user group, the total variance explained was 33%; for the discontinued users, 18%. The best predictors of computer use were resource availability, attitude, training, training adequacy, and distance to technical resources (significant at the .001 level). These were followed by the variables of grade range, teaching experience, city size, and school size (significant at the .05 level). The results indicate that computer availability is the single most important variable but accounts for only half of the explained variation with attitude and training explaining most of the other half. They conclude, therefore, that technological determinism is not an adequate explanation for computer adoption. This study takes into account more of the possible predictors of computer use than any of the other studies. These predictors are related directly to the constructs of the diffusion theory with the possible exception of "resource availability." Anderson's research also employs the same design and analysis that is proposed for this research except for the target population. As such, it has the same limitations that were discussed earlier in this paper. Interestingly, Anderson does not explain why only current users and discontinued users were included and non-users were eliminated. A more appropriate distinction would seem to be current users compared to discontinued users/nonusers or a comparison among all three groups.

Other Related Studies

Studies on the variables affecting computer implementation fall into two categories: (1) those with data based on surveys of institutions and their faculty; and (2) those representing opinions of authors as to what is preventing greater computer use (presumably from personal experience). By far, the greatest part of the literature falls in the second category. The only data based surveys are by Rockart and Scott-Morton (1975) and the CONDUIT survey (Johnson, 1977).

The CONDUIT nationwide survey of department heads revealed that the major reasons for lack of computer use were: (1) lack of training (32%); (2) lack of equipment (22%); (3) lack of funds (12%); (4) lack of time (12%); (5) lack of interest; and (6) no applications (10%). Interestingly in spite of all of the uses of computers, 10% of department heads felt there was no applications in their discipline! Several "reasons" on the CONDUIT list are constructs of the diffusion theory. Lack of time and interest implies attitudes. Lack of applications implies no perceived relative advantage to the computer, and lack of training (education) is a social system attribute. The results are also interesting since the most commonly assumed reasons for lack of computer use are lack of proven effectiveness and antipathy toward computers but these responses were not evident in the survey (except possibly for the 10% giving "lack of interest"). Johnson cautions (and rightfully so) that one should be careful in interpreting the results since other factors might still be important in many situations.

As a part of a lengthy questionnaire, Rockart and Scott-Morton sampled faculty (152) nationwide and asked them to rank each of five groupings as to how much of an obstacle each one presented to the adoption of ten forms of computer instructional uses. The ranking in order of most to least severe of an obstacle were: (1) funding; (2) faculty attitudes; (3) technology effectiveness; (4) student attitude; and (5) administration attitudes. For some reason, the tabulated results were not included. This is unfortunate because the magnitude of differences within the order of the "obstacles" can not be determined. The authors are surprised that faculty attitudes rank ahead of technology effectiveness - the CONDUIT survey found faculty attitude to be less important. Again, faculty attitudes and technology effectiveness (relative advantage) are diffusion theory constructs. This survey had its limitations in that respondents had to choose from a list of only five items with no subcategories.

One general research article of interest does not study computer use, but innovations in general. Aslin and DeArman (1976) examine the adoption and abandonment of classroom innovation in public schools as it relates to characteristics of the innovation and of the schools. They found that schools most often abandoned innovations that were complex, expensive, difficult to administer and required changes in the existing structural framework. Possibly for these reasons, there was a greater adoption of curricular as opposed to technological innovations. School enrollment and per pupil expenditures were linearly related to the number of innovations used. The size variables relate somewhat to the cosmopolitan construct in the social system. The difficulty with technological innovations seems to involve the complexity attribute of the innovation.

The non-research based compilations of possible variables generally fit into one of Johnson's five or Rockart and Scott-Morton's first three categories. Funding problems are mentioned by Grimm (1978) who sepcifically mentions the high cost of an off-campus time-shared computer (costs of computer time and telephone calls can become prohibitive). Grimm also lists as variables affecting computer use: (1) instructors may feel threatened by the computer; (2) large amounts of time may be required to prepare programs as compared to other teaching methods; and (3) logistics problems- lack of enough terminals, computer down time, and phone line problems. Lindquist (1977) discusses five obstacles to curriculum development which, although written from an institution-wide perspective, has merit when considering variables that affect computer adoption. His categories are: (1) inertia- policies and budgets are geared to maintaining existing practises; (2) traditional socialization- faculty teach the way they were taught; (3) inadequate information; (4) traditional departmental structures and the reward structure; and (5) fear of the unknown. Again, most of these categories are social system variables (attitudes, education, and position in the social structure). Rockart and Scott-Morton (1975) although giving no evidence for their list include eight factors that will tend to minimize the amount of new technology adopted. Most of the eight factors relate to the one area of faculty attitudes and are: (1) the research orientation of faculty; (2) the need to learn a new discipline; (3) faculty laziness; (4) financial stress in a diminished student market; (5) inherent faculty conservatism; (6) the "teach it my own way" syndrone; (7) faculty being too overloaded with other duties; and (8) unionization tending to minimize changes in work roles.

The one variable that has been discussed more than any other has been faculty attitudes toward innovation. Most of Lindquist's and Rockart and Scott-Morton's variables fit this category. Jay (1981) emphasizes faculty fear of the computer (which he calls "computerphobia") as a variable inhibiting computer use. He considers it's cause to be the failure of faculty to keep up with the rapid increase in technological advances. Several authors have pointed out that faculty have so many demends on their time (research, developing courses, grading papers, serving on committees, etc.) that it is difficult for them to find enough time to develop computer programs. In a broader sense, as Jay concludes, many faculty are not even able to keep up with the technology. Jay's "cure" for computerphobia is for faculty to use the computer enough so that they have the control and confidence which comes from understanding the technology. But how do they accomplish this "understanding" if they don't have the time? Parkhurst (1977) states that some of the resistance to computer innovations comes because of a lack of faculty knowledge. In many cases, faculty feel that existing computer programs need to be modified but they don't know how to do it (this is where a local "expert" programmer would be invaluable!). Parkhurst recommends a "computer awareness program" (apparently courses, seminars, or workshops) where faculty learn the strengths, weaknesses and limitations of computers. Parkhurst also recommends learning the following basic topics: computer logic, flowcharting, branching techniques and computer languages. He says that all faculty do not need to know how to write programs, but they do need to be knowledgeable enough to communicate with a programmer about their needs. American Education magazine (1979) mentions several colleges and NSF funded seminars that train teachers (primarily public school teachers) in computer use. Courses for college faculty are not mentioned but presumably they could be conducted by within-college seminars and workshops. The magazine quotes an NSF survey that found 40% of college graduates have some knowledge of computers but only about 10-20% of college faculty know enough to use them in the classroom.

Summary of the Literature

The measurement of many constructs of the diffusion theory has seldom been done in one study in an educational setting. Kozma (1978) attempted to follow the diffusion of innovations in a university faculty but found no increase in adoptions. Anderson etal (1979) in a study that is very similar to the one proposed here, measured several attributes that affect diffusion and used multiple regression analysis to determine which variables were better predictors of computer use and discontinued use. Anderson's theoretical bases were technological determinism and sociological change whereas this study is based only on the diffusion theory (one of the many sociological theories). Other studies, although not measuring many different aspects of diffusion, still provide strong evidence for the inclusion of these constructs in the present study. Evans (1967) did a detailed study of faculty attitudes toward a technological innovation (instructional television) and Stern etal (1976) point to the importance of relative centrality as a social system construct in the diffusion theory.

Several authors (Johnson, 1977; Rockart and Scott-Morton, 1975; Grimm, 1978; Lindquist, 1977; Aslin and DeArman, 1976) analyzed the relative importance of many factors which could affect the adoption of computers. Support for the importance of these factors comes from the fact that many of the same factors were found in several different studies. Almost all of these factors are found included in the diffusion theory constructs. The most commonly listed factors seemed to involve some attitude of the faculty but lack of equipment (cost factors), lack of training, and attributes of the innovation (effectiveness, complexity) were also prominently mentioned. These major groupings of important factors mentioned in this summary will be developed as the independent variables in this study.

CHAPTER III

METHODOLOGY

Population and Sampling

The Virginia Community College System includes 23 colleges employing 1838 full time faculty members in all disciplines (AAUP, 1983). The number of full time faculty employed at each college and the percentage of females among their ranks is given in Table 3.1. A majority of the VCCS faculty hold the masters degree and very few have a doctorate. A survey of college catalogues of four colleges employing around 25% of the total faculty found that 76.2% of the faculty held the masters degree, 14.5% had less than a masters and only 9.3% had a doctorate. Almost all faculty are teaching faculty with no research involvement.

The computer facilities within the VCCS include 4 regional IBM 4341 mainframe computers. Terminals are available at the local college (usually IBM 3270 or TELEX 278 models) which are connected by phone lines to the nearest regional computer. The computer runs the MUSIC software package (McGill University System for Interactive Computing) which is relatively easy to use, provides several programming languages, and can support a variety of different uses. The system seems to be used primarily by data processing and computer science students. The number of existing terminals in the colleges prior to

TABLE 3.1

FACULTY NUMBER AND COMPUTER FACILITIES
IN THE COLLEGES OF THE VCCS

Institution	Faculty Number	% Female	MUSIC System	# of Micros	Micros in '84
Northern Virginia CC	496	48	120	269	68
Tidewater CC	262	38	174	26	—
J. Sargeant Reynolds CC	150	48	64	88	52
Thomas Nelson CC	123	30	27	27	31
Virginia Western CC	113	41	38	12	—
Central Virginia CC	68	35	28	22	20
John Tyler CC	75	40	42	36	10
Danville CC	70	27	26	10	1
New River CC	56	44	15	27	25
Southwest Virginia CC	57	30	15	45	46
Piedmont Virginia CC	55	42	—	—	—
Virginia Highlands CC	52	39	30	11	4
Wytheville CC	47	42	22	19	28
Blue Ridge CC	46	26	32	5	18
Southside CC	40	30	18	62	12
Paul D. Camp CC	30	32	16	11	6
Mountain Empire CC	44	18	10	0	0
Dabney S. Lancaster CC	24	36	13	15	7
Germana CC	28	50	9	8	0
Patrick Henry CC	31	52	26	20	15
Rappahannock CC	27	27	6	24	9
Eastern Shore CC	11	33	0	16	0
Lord Fairfax CC	34	—	17	12	18

1984 are given on Table 3.1. This data on computer facilities came from an internal report compiled by the procurement office of the VCCS. Eastern Shore Community College is shown as having no terminals into the MUSIC system and data was not available for Piedmont Virginia Community College. All other colleges are hooked into the MUSIC system. The number of computers outside of the MUSIC system are assumed to be some model of microcomputer (except for Northern Virginia Community College which is known to have the TICCIT instructional computer system). These numbers for the 23 colleges are also shown in the table. The last column in the table indicates the additional number of microcomputers that the colleges purchased in 1984. During the summer of that year, the Virginia General Assembly released a large sum of money to be used by colleges for updating and replacing equipment as well as for the purchase of high technology equipment. The high number of purchases by so many of the colleges in just one year is probably attributable to these additional state funds. Apparently, only Mountain Empire Community College has no microcomputers. Germana Community College seems to have a low number of micros (8) for the size of the school and again, data for Piedmont Virginia Community College is not available.

The target population for this study included a sample of full time faculty (excluding data processing, computer science, and word processing disciplines) employed in colleges that utilize computers in instruction. To identify these colleges, letters were sent to the Deans of Instruction at 22 colleges requesting an estimate of the number of their faculty who used computers to supplement their instruction. Three colleges reported no instructional computer use and in two others, the number was so low that it did not seem practical to include the colleges in the study. Two colleges failed to respond to several inquiries. Tidewater Community College was selected for pilot testing of the questionnaire, so that the study involved faculty in fifteen colleges.

After receiving permission from the fifteen college presidents to sample their faculty, the Deans of Instruction were asked in a second letter to compile a list of faculty who used computers in their teaching. A matching random sample of faculty who did not use computers was made from the faculty listings in the college catalogues. These faculty were chosen from within the college and division of the computer users whenever possible. When this procedure was not possible in some of the smaller schools and divisions, faculty were randomly selected from the same division or discipline in similar sized colleges. The sample thus represents a stratified random sample in time since the number of faculty who use or do not use computers will change from one academic year to another.

Stratification of the sample by school size, and academic discipline was considered but discarded. One might hypothesize that the size of the school would affect the number of computer users because of the cosmopolitanism aspect of diffusion theory which predicts that more users would be found in larger schools located in urban areas. This does not seem to be the case in the Virginia community colleges. Some of the most active colleges in terms of academic computing are the smaller ones- Paul D. Camp Community

College, Virginia Highlands Community College, Rapahannock Community College, and Southwest Virginia Community College. On the other hand, smaller schools such as Southside Virginia Community College, Blue Ridge Community College, and Patrick Henry Community College are not using computers in too many non-data processing areas. Although larger schools such as J. Sargeant Reynolds Community College and Northern Virginia Community College are making some use of computers in instruction, Tidewater Community College and Virginia Western Community College are not in any great numbers. Therefore, stratification by school size would not compensate for underrepresentation from smaller schools and might, in fact, overcompensate. Stratification by academic discipline would have another inherent problem. Community college faculty can not be conveniently divided into traditional disciplinary groups because of the large number of occupational/technical faculty. The issue of measuring the disciplinary variable will be discussed later in this chapter.

The questionnaire to measure variables that affect computer adoption was assembled by the researcher. Content validity was determined by seeking the expertise of doctorate level faculty at Tidewater Community College who have been very active in using computers in their classes. They were asked for input on the appropriateness and comprehensiveness of the items and any suggestions on wording. They were qualified to judge whether the questionnaire items were representative of the "universe" of all items measuring the attributes and attitudes mentioned in Chapter I.

Reliability was determined from the results of a pilot study. A small sample of faculty at Tidewater Community College was tested using the questionnaire. Results of this study was used to refine the questionnaire before sending it to the sample. The items on the questionnaire concerning attitudes toward computers had already been pilot tested by Ellsworth and Bowman (1982). They utilized a list of 17 questions written by Ahl in 1976 to measure the general public's attitude toward computers. Ellsworth and Bowman first tested the instrument on a favorable population (computer science students) to determine the direction of a favorable response on all items. Over 50% of the population had to be in agreement with a statement about computers before it would be included in the instrument. The questionnaire was then administered to a general biology class and retested in one month. The test-retest reliability was .85 and internal consistancy on the first test using coefficient alpha was .77. As expected, the group scored significantly lower than the more favorable computer science group ($p < .01$).

After receiving the recommendations of the computer expert faculty at Tidewater Community College, analyzing the results of the pilot study and receiving recommendations from the dissertation advisor, the questionnaire was revised once more and type-set at the Print Shop at Tidewater Community College. The questionnaires were then distributed to the faculty sample by mail along with a cover letter and a stamped return envelope. Initial mailing and followup techniques were modifications of Dillman's (1978) "Total Design Method." A followup reminder postcard was mailed one week after the initial mailing. A second followup after two weeks consisted of a letter appealing for the return of the replacement questionnaire which was enclosed with another stamped return envelope. After four weeks, a third followup letter was mailed. This letter presented a stronger appeal, contained a personal first name or nickname salutation, and included a replacement questionnaire and a stamped return envelope. Six weeks after the initial mailing, phone calls were made to personal acquaintances on the faculty of ten of the fifteen colleges. These individuals were asked to talk to the nonrespondents at their college and try to convince them to return the questionnaire. These individuals also hand delivered another replacement questionnaire and a stamped return envelope.

Ethical safeguards were not a strong factor in this research since subjects were not being manipulated by treatments. The respondents were reasonably certain that the goal of the research was related to their use of computers by merely reading the questionnaire items. They did not, however, know that their responses would be used as possible predictors of whether they used computers or not. The questionnaire items were constructed so that the wording was as value neutral as possible, thus eliminating researcher bias and lack of support by non-users in the sample.

Instrumentation

The questionnaire was assembled to measure the following attributes: (1) faculty attitudes toward computers; (2) faculty innovativeness; (3) knowledge of computer logic; (4) presence of opinion leaders and change agents; (5) adequacy of computer facilities; and (6) faculty demographics. A brief rationale and a listing of questionnaire items by construct category follows. The questionnaire with all of the following items is reproduced in the Appendix. All items involving a Likert scale were placed in one section for the convenience of the respondent.

Faculty attitudes

Chapter II emphasizes that faculty attitude toward an innovation is a variable related to the adoption or nonadoption of the innovation according to the diffusion theory. A series of 17 opinion statements comprising Ellsworth and Bowman's (1982) "Beliefs about Computers" scale were included and faculty were asked to check on a 5-level Likert scale the degree to which they agree or disagree. Responses on items indicating a positive attitude were given higher point values so that a score of 17 (17 x 1) reflected the lowest negative attitude score and a score of 85 (17 x 5) indicated the highest positive attitude score. The 17 items are listed below.

A person today cannot escape the influence of computers

Computers are beyond the understanding of the typical person

Credit rating data banks are a worthwhile use of computers

Our country would be better off if there were no computers

Computers make mistakes at least 10% of the time.

Computers are a tool, just like a hammer or lathe.

Computers will improve health care.

Someday I will have a computer or a computer terminal in my home.

Programmers and operators make mistakes but computers are, for the most part, error free.

Computers slow down and complicate simple business operations.

Computers will improve law enforcement.

A computer may someday take my job.

Computers isolate people by preventing normal social interactions among users.

It is possible to design computer systems which protect the privacy of data.

Computers will replace low-skill jobs and create jobs needing specialized training.

Computers will improve education.

Computers will create as many jobs as they eliminate.

Faculty innovativeness

To assess the use of classroom innovations in general, the faculty were asked:

Not including laboratory classes, which of the following teaching methods or techniques have you used at any time in the past 5 years? Place a check mark in the blank next to each category that you have used. Please add any methods that you have used that are not on the list.

a. transparencies or Kodachrome slides
b. videotapes or movies
c. classroom demonstrations
d. field trips
e. student discussion groups
f. term papers, written reports, or essays
g. lecture
h. student self-paced techniques

i. student contracted learning
j. other methods or approaches (please list)

This item assumes that greater use of innovations in the classroom in the past is an indicator of a more positive attitude toward innovation.

Faculty knowledge

Knowledge of computer operations are measured here and also as the "level of training" aspect of faculty demographics. The rationale for including computer knowledge is that innovations diffuse slowly through an untrained social system according to Rogers and Shoemaker (1971). This knowledge will be assessed by a brief set of multiple choice questions about computer logic and flowcharting. These five multiple choice questions are listed in order of increasing complexity. Because of the amount of space required, these items are printed only on the questionnaire in the Appendix as items 40 through 44.

Opinion leaders and change agents

Rogers and Shoemaker (1971) have indicated that opinion leaders and change agents are attributes of the social system that affect the diffusion of an innovation. An opinion leader, as defined in Chapter I is a member of the social system that influences a decision to adopt an innovation- in this case, the faculty member's colleagues. Change agents are individuals outside of the faculty that attempt to influence an adoption decision- here they are represented by the college or VCCS administration. These attributes were presented as two questions to which the faculty responded on a Likert scale to the first one.

The administration of my college is supportive of computer use in the classroom.

At your college, how many of your colleagues with which you are personally acquainted, are using computers for instructional purposes in their classes or labs? (do not count computer science or data processing faculty)

<u>Adequacy of the facilities</u>

Anderson et al (1979) found that "resource amount" and "resource availability" were the most significant variables in predicting computer use. The availability of a technological innovation is a factor of the complexity and trialability attributes of the innovation according to the diffusion theory.

In this study, availability is operationally defined as having an adequate number of computer terminals (the exact number dependent on the level of instructional computer use) and adequate knowledgeable assistance both to students at the terminals and to faculty in their programming tasks. The adequacy of computer facilities is assessed by asking the respondent five questions from which they will answer on a Likert scale.

The computing facilities at my college are readily available for use by my students.

The number of MUSIC terminals and microcomputers at this college are adequate for the number of students who need them.

My students are able to get enough help from the staff or student workers in order to do their assignments on the computer.

The location of microcomputers and MUSIC terminals at this college and the times that they are available are adequate for the number of students who need them.

There are individuals in my college that are experts in computer use and I can get assistance from them whenever I need it.

Another factor concerning facilities that is unrelated to hardware and personnel support, is the adequacy of the software. Unlike audio and video cassette tapes, computer tapes and floppy disks will only run on the machine for which they have been formatted. If a faculty member has software available for an Apple computer and his college has only IBM PC computers, he will not be able to use the software. Also, if the hardware and software were compatable, faculty might not use computers in their classes if they did not like the content or presentation of the material in the available software. To measure these variables, faculty were asked to respond "yes" or "no" to the first question below, and on a Likert scale on the other two questions.

Have you had an opportunity to preview any computer software that is available for your teaching field?

Generally, the software that is available for use in my discipline will run on the microcomputers at this college.

I could effectively utilize the software on the market in the courses that I teach.

Faculty demographics

Demographic variables of the faculty that might affect computer use include sex, years of teaching experience, verbal versus quantitative orientation, level of training, size of the college, ownership of a home computer, and perceived usefulness of available computer software. Sex, although not found to be a significant predictor by Anderson et al (1979), should be included as a variable in this study since other research indicates that it could be an important variable in some settings.

The number of years of teaching experience is a social system variable that seems to be overlooked in most studies but might be a significant variable. Opinion is divided on whether longevity in teaching will enhance or inhibit computer adoption. Years of experience usually translates to faculty rank in the VCCS which affects position in the social system. Anderson et al (1979) states that longevity is often associated with rigidity and resistance to innovations, but seniority can also provide access to preferred geographic locations (cosmopolitanism) or preferred courses (some advanced courses may tend to use computers to a greater extent). The faculty sample was asked to list the number of years of teaching experience in public schools (K through 12), community college(s), 4-year colleges or universities, and total teaching experience. Longevity in each of these experience categories might be a factor in determining whether the faculty member would use computers instructionally.

Another faculty demographic variable that could possibly affect adoption of computers is the faculty member's academic discipline. Studies indicate that computers are used more often in instruction by faculty in science, mathematics, and business and less often by faculty in humanities and social science. Unfortunately, there is no way to conveniently code for the academic discipline variable. Even if a 0 or 1 coding were used for 2 disciplinary groupings, community colleges have a high number of occupational program faculty for which a designation would be arbitrary and with no research to support it. The closest that one could get to assessing the discipline variable would be to measure the faculty member's orientation toward either verbal, cognitive preference or quantitative, analytical preference. The former style would be more characteristic of humanities and social science faculty and the latter more characteristic of mathematics, science, and business faculty. This assessment also has the advantage of being able to measure more subtle differences in orientation in the math-science-business and the humanities-social science groups. Although scales were available to measure cognitive versus analytical skills, they were too lengthy to be included in an efficient questionnaire. The only resort remaining was to construct a series of Likert scale items. The respondent was asked to place himself along a continuum on the items which asked him about his verbal or quantitative orientation. The 4 items included in the questionnaire to measure this variable are listed below.

On standardized tests, I usually scored higher on the verbal sections than on the quantitative sections.

In my college coursework, I was more successful in mathematics and science courses than in English and history courses.

I tend to consider myself as more oriented toward words and ideas than toward numbers and computation.

My academic discipline deals more with analytical or mathematical concepts than verbal or other cognitive concepts.

Higher scores on items 1 and 3 and lower scores on items 2 and 4 indicated a verbal orientation and the opposite would be true of quantitative orientation. The coding was arranged so that the verbal scores would be high and quantitative scores would be low. The lowest quantitative score would be 4 (1 point on each of 4 questions), the highest verbal score would be 20 (5 points on each of 4 questions), and the neutral point would be 12 (an average of 3 points on each of 4 questions). These four questions were pilot tested on a faculty sample at Tidewater Community College. Out of 33 respondents, only 2 had a score of 12 and only 4 had adjacent scores of 11 and 13. The mean of all scores below 12 (quantitative) was 8.4 (N = 13) and the mean of all scores above 12 (verbal) was 15.9 (N = 19). A t-test indicated that the difference in the means was significant at the 1% level. The mean of the 7 English and social science faculty was even higher, 17.4, but the mean of the 9 science and mathematics faculty was 8.9 (similar to the means of "under 12" scores). Only 3 faculty on the sample of 33 gave 3 or 4 "undecided" scores and only 6 gave inconsistent scores (high or low on both verbal and quantitative questions). These results seem to indicate that these questions can adequately separate faculty tendency toward verbal or quantitative orientation.

The degree of training in computer use, both formal and informal, can be a factor in whether computers are used instructionally or not. Education level, according to Rogers and Shoemaker (1971) is a very important social system variable that affects diffusion. As mentioned previously, innovations diffuse slowly through an untrained social system. In this case, education is interpreted to mean training in computer use, since overall education level is similar for all respondents and would probably not be a significant factor. Faculty were asked to respond to the following question that was designed to determine what kinds of educational experiences the respondent has had with a computer.

Have you engaged in training or acquired knowledge (through courses, workshops, independent study) about computers or computer use in education? If the answer is "yes", please give the number of CREDIT HOURS for courses and the number of CLOCK HOURS for workshops, seminars, or independent study, in each of the following computer subject areas.

(1) computer use in your discipline
(2) business data processing
(3) fundamental computer knowledge
(4) uses of computers in education
(5) computer science
(6) other (please specify)

The effect of school size is related to cosmopolitanism which is a diffusion theory construct that refers to individuals who have reference to outside sources by exposure, travel, etc. (Rogers & Shoemaker, 1971). Cosmopolitan individuals have been shown to accept innovations at a higher rate than others. There is a tendency to associate cosmopolitanism with larger population centers since there is greater accessibility to technological as well as informational resources (Anderson et al, 1979). One could predict that smaller community colleges (invariably in smaller communities in Virginia) due to their faculty size, would be less likely to be exposed to new innovations and have fewer opinion leaders or "in-house" computer experts. School size cannot be entered as a variable in the discriminant analysis since the faculty sample was constructed so that there would be an equal number of users and nonusers from each college regardless of size. The effect of school size can be determined alternately by calculating the percentage of computer users to total faculty in all 15 colleges and then comparing these numbers in relation to college size.

The respondents were asked if they had a personal computer at home. Use of a computer in instruction might be affected by whether or not the faculty member has had prior experience by using a microcomputer at home. This person may have had no formal training or any programming knowledge but has used his home computer with commercial software and appreciates its potential.

The faculty sample were asked if they had used a computer in the past two years for noninstructional academic uses such as word processing, for preparing handouts and tests, or in computing and storing student grades. The rationale for this variable is that faculty who have used a computer for any of these uses might be more likely to use the computer in classroom instruction.

Statistical Analysis

The statistical analysis was performed by using stepwise discriminant analysis (Wilks method) in the SPSSX statistical package. Use or non-use of computers in instruction was the nominal dependent variable. The 18 variables discussed under the "Instrumentation" section were the independent variables which attempted to separate or discriminate between computer users and non-users in the faculty population.

Non-users were coded as "1" and users coded as "2". The coding of the 18 independent variables for data entry were performed as follows:

1. Faculty attitudes toward computers	1. Total points on Likert scaled items in direction of positive attitudes. (items 11-27 on the questionnaire)
2. Faculty innovativeness	2. Number of innovations used in past 5 years. (item 10)
3. Knowledge of computer logic/programming	3. Number of questions out 5 answered correctly (items 40-44)
4. Presence of change agents	4. Likert score on 1 item (item 30)
5. Presence of opinion leaders	5. Number of colleagues using the computer (item 4)
6. Adequacy of computer facilities	6. Total points on Likert scaled items in the direction of adequacy (items 31-35)
7. Opportunity of preview software	7. No = 0; Yes = 1 (item 6)
8. Does software run on college computers?	8. Likert score on 1 item (item 36)

9. Could software be used effectively?	9. Likert score on 1 item (item 39)
10. Noninstructional academic computer uses	10. No = 0; Yes = 1 (item 2)
11. Sex	11. 0 for male; 1 for female (item 8)
12-15. Years of teaching experience	12. Number of years of experience in public schools, community colleges, 4-year colleges, and total experience
16. Verbal vs quantitative orientation	16. Total points on Likert scaled items in the direction of verbal orientation (items 28-29 and 37-38)
17. Level of training	17. Total number indicated (item 7)
18. Ownership of a home computer	18. No = 0; Yes = 1 (item 3)

With only two groups to discriminate, a single discriminant function is produced. In the stepwise method, the variable that is best able to separate or discriminate between the two groups is selected and enters the function first. Then other variables are selected one at a time based on their ability to further discriminate using information not already available in the previous variables. Later, a variable might be dropped from the discriminant function if its information about group differences is already available in the other variables. This selection procedure continues until later variables no longer make a significant contribution to discriminating the two groups. A specified significance level of 0.05 was the level that the calculated partial F ratio of the variable must meet before it can enter into or be removed from the discriminant function. This significance level is achieved by specifying the probability level at which a variable would enter the function (PIN = .05) and the probability level at which the variable would be removed from the function (POUT = .06). When variables can no longer meet this criterion, inclusion of variables ceases and the summary statistics are given.

In order to avoid possible rounding off errors, faulty estimates, and inaccurate classifications, a tolerance level of .01 was set. The PIN, POUT, and tolerance levels are more restrictive than the default criteria, thus producing a more rigorous evaluation of the variables.

Summary

A sample of Virginia community college faculty at 15 colleges was selected in which approximately half had used computers in their instruction. The deans of instruction at these colleges were instrumental in providing a list of faculty who had used computers in their teaching. The sample was mailed a questionnaire which was designed to measure variables which could possibly discriminate between users and nonusers of computers. This questionnaire had previously been examined by computer user doctorate faculty and pilot tested at a community college. Efficient followup techniques were employed to insure a high response rate.

The variables that were measured were those included as major constructs of the diffusion of innovations theory which was the theory which guided this study. These variables included the following environmental context variables: presence of change agents and opinion leaders; adequacy of computer facilities; adequacy and usefulness of available computer software; and opportunity to preview computer software. The attributes associated with the individual faculty member included sex, years of teaching experience, attitude toward computers, innovativeness, knowledge of computer programming, level of training, verbal versus quantitative orientation, noninstructional academic computer usage, and ownership of a home computer.

The data was analyzed by stepwise discriminant analysis using Wilks method in an attempt to discover the variables which when taken together could best discriminate between faculty who used computers insturctionally and those who did not.

CHAPTER IV

ANALYSIS OF RESULTS

Composition of the Sample

Questionnaires were mailed to a sample of 528 faculty members. Later it was learned that 19 of these faculty had left the college or were on leave of absence. Thus, only 509 questionnaires were delivered, and returns were received from 458 faculty. Three faculty responded but declined to participate in the study and two responded that they had been administrators for two years and had not taught in the classroom. Seven questionnaires were not useable due to the fact that they did not indicate whether they had used computers instructionally (item number 1 on the questionnaire). Useable responses were received from 446 faculty. Only 51 faculty failed to respond which was only 10% of the total number of deliverable questionnaires. According to the list received originally from the deans, approximately half of the nonrespondents were computer users. Apparently there was no bias among the nonrespondents in reference to their instructional computer usage.

In the useable sample of 446 faculty, there were 212 computer users and 234 nonusers. The distribution of these two groups by academic discipline within each college and the totals for each discipline is shown in Table 4.1. The disciplines with the largest number of

TABLE 4.1

NUMBER OF FACULTY NOT USING (NU) AND USING (U) COMPUTERS BY DISCIPLINE IN THE 15 COLLEGES

Discipline	Totals		VHCC		DCC		CVCC		BRCC		PVCC		PHCC		RCC	
	NU	U	NU	U	NU	U	NU	U	NU	U	NU	U	NU	U	NU	U
Mathematics	28	38	1	4	2	0	3	2	2	4	1	3	1	0	2	1
Biology	12	5	2	1	3	0	1	0	0	0	0	0	1	0	1	0
Chemistry	7	13	0	1	1	0	0	2	0	0	0	0	0	1	1	0
Physics	3	7	0	0	0	1	0	1	0	0	0	1	0	0	0	0
Business	29	31	0	3	1	2	1	3	1	1	1	2	1	2	0	1
Accounting	9	20	0	0	0	2	1	1	0	0	0	3	0	1	0	1
English	35	21	1	2	2	0	0	2	1	1	1	1	2	0	2	2
Arts	9	2	1	0	0	0	2	1	0	0	0	0	0	0	0	0
Foreign Languages	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Psychology	9	5	0	0	0	0	0	0	0	1	0	2	0	0	0	0
Sociology	3	4	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Economics	4	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Political Science	1	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Engineering	3	13	1	1	0	0	0	2	0	1	0	1	0	0	0	0
Drafting	6	8	0	2	0	2	2	1	0	0	0	0	0	0	1	0
Electronics/Electricity	2	16	0	2	0	2	0	3	0	1	0	1	1	0	0	0
Air Conditioning	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Physical Education	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Nursing	17	11	7	4	0	0	0	0	0	0	0	0	0	0	0	0
Allied Health	8	17	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Other Occupational	9	13	1	1	1	2	1	1	0	1	0	0	0	0	0	1

Key: VHCC= Virginia Highlands CC; DCC= Danville CC; CVCC= Central Virginia CC; BRCC= Blue Ridge CC; PVCC= Piedmont Virginia CC; PHCC= Patrick Henry CC; RCC= Rappahannock CC.

TABLE 4.1-Continued

Discipline	DSLCC		PDCCC		WCC		TNCC		VWCC		JSRCC		SVCC		NVCC	
	NU	U	NU	U	NU	U	NU	U	NU	U	NU	U	NU	U	NU	U
Mathematics	2	0	0	2	1	2	3	4	4	4	3	3	1	1	4	9
Biology	0	2	0	0	0	0	2	0	1	0	0	2	0	0	1	0
Chemistry	0	0	0	0	1	0	0	1	1	0	2	0	0	0	1	9
Physics	0	0	0	1	0	1	0	1	2	0	1	0	0	1	0	0
Business	3	1	2	1	2	1	2	2	3	1	5	1	4	3	3	7
Accounting	0	0	0	0	0	0	1	1	1	2	1	4	0	0	5	8
English	1	1	1	1	6	0	3	2	0	0	2	1	0	0	13	8
Arts	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1
Foreign Languages	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
Psychology	1	0	2	0	0	1	2	0	0	0	0	0	0	0	5	1
Sociology	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1
Economics	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Political Science	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Engineering	0	0	0	0	0	1	0	1	0	3	2	1	0	0	0	2
Drafting	0	0	1	0	0	1	2	1	0	0	0	1	0	0	0	0
Electronics/Electricity	0	1	0	1	0	1	1	1	0	0	0	0	0	1	0	2
Air Conditioning	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Physical Education	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
Nursing	3	0	0	0	5	3	1	0	0	0	1	1	0	1	0	2
Allied Health	0	0	0	0	0	2	0	0	0	0	1	1	0	1	6	12
Other Occupational	0	1	1	1	1	1	3	1	0	0	0	0	1	2	0	1

Key: DSLCC= Dabney S. Lancaster CC; PDCCC= Paul D. Camp CC; WCC= Wytheville CC;
TNCC= Thomas Nelson CC; VWCC= Virginia Western CC; JSRCC= J. Sargeant Reynolds CC;
SVCC= Southwest Virginia CC; NVCC= Northern Virginia CC.

computer users were mathematics (38), business (31), accounting (20), English (21), allied health (17), electronics (16), engineering (13), occupational programs (13), and nursing (11). Several disciplines are represented almost equally in the 2 groups. Other disciplines show a disproportionately high number of computer users (chemistry, accounting, engineering, electronics, and allied health). A few disciplines seem to have a disproportionate number of faculty who don't use computers (biology, English, arts, psychology, and nursing).

There are reasons for this disproportionality from an original sample with an almost equal balance. The 51 nonrespondents, although balanced by computer use or nonuse, were not balanced by discipline. There was also no balance of disciplines in the 19 nondeliverable and 7 nonuseable questionnaires. Another factor seemed to be the accuracy of the original list of computer users that the deans compiled. Data from returned questionnaires indicated that the deans would occasionally list a faculty member as a computer user when the faculty member's response indicated that this was not the case. Also, some respondents indicated that they had used computers even though the dean did not include them on his list. These faculty had been originally selected randomly as being nonusers since they had not appeared on the dean's list of computer users.

Table 4.2 lists the names of the 15 colleges in the sample and gives the number of full-time faculty at the college in 1983, and the percentage of the faculty who use computers. This percentage is somewhat conservative since the computer usage of nonrespondents and

TABLE 4.2

PERCENTAGE OF COMPUTER USING FACULTY
IN THE 15 COLLEGES

College	Faculty Number	Percentage
Virginia Highlands CC	52	44
Danville CC	70	16
Central Virginia CC	68	28
Blue Ridge CC	46	22
Piedmont Virginia CC	55	27
Patrick Henry CC	31	16
Rappahannock CC	27	28
Dabney S. Lancaster CC	24	29
Paul D. Camp CC	30	23
Wytheville CC	47	30
Thomas Nelson CC	123	12
Virginia Western CC	113	10
J. Sargeant Reynolds CC	150	11
Southwest Virginia CC	40	20
Northern Virginia CC	496	13
Overall Average		15

unuseable respondents is not included and there may be a few more computer-using faculty who were not included in the sample because the deans did not include their name on the list. The lowest percentage of computer users (11-13%) was at the four largest colleges in the sample. The nearest percentages to these were two 16% values. One was at one of the smaller colleges and the other at a middle sized college. If the full-time faculty numbers at the four largest colleges (882) were subtracted from the VCCS total (1388) the remaining 506 faculty would still include half of the computer users in the VCCS (106).

Results of the Discriminant Analysis

Stepwise discriminant analysis revealed 9 variables that met the statistical criteria for contributing to the discrimination of computer users from nonusers. The variables are listed in Table 4.3 in the order that they entered the discriminant function along with their computed standardized canonical discriminant function coefficient. The mean scores of the computer user group and the nonuser group for the 18 variables along with the overall mean is given in Table 4.4. The percentage of cases correctly identified was 70.45%. The percentage of computer users correctly identified was 74.6% which was better than the percentage of nonusers correctly identified (65.9%). The discriminant analysis was also run using the default criteria for PIN, POUT, and tolerance. This analysis yielded 14 useful variables but a percentage of cases correctly identified of 71.59% was only slightly more than 1% higher than the percentages achieved using the more stringent

TABLE 4.3

VARIABLES ENTERING AT EACH STEP IN THE DISCRIMINANT ANALYSIS AND THEIR CANONICAL COEFFICIENT

Step	Variable	Canonical Coefficient
1	Opportunity to preview software	.49869
2	Noninstructional academic computer use	.31003
3	Ownership of a microcomputer	.33724
4	Could software be used effectively	.23361
5	Level of training	.28865
6	Community college teaching experience	-.23438
7	Verbal versus quantitative orientation	-.19903
8	Compatability of software with hardware	.33060
9	Presence of opinion leaders	-.32205

TABLE 4.4

MEANS FOR THE NONUSER AND USER GROUPS
WITH GRAND MEAN FOR THE 18 VARIABLES

Variable	Nonusers mean	Users mean	Grand mean
Noninstructional academic computer use	43.7%	69.3%	57.2%
Ownership of a microcomputer	23.0%	50.8%	37.7%
Number of colleagues using computers	10.2	12.8	11.5
Opportunity of preview software	63.0%	87.9%	76.1%
Level of training (in hours)	40.0	136.5	90.9
Percentage of males	41.3	49.6	45.7
Public school teaching experience	3.0	2.0	2.5
Community college teaching experience	12.6	10.8	11.7
Four year college teaching experience	2.7	2.2	2.4
Total teaching experience	15.8	14.1	14.9
Number of differenct teaching techniques used	6.9	6.8	6.85
Attitude toward computers (80 point scale)	65.3	68.0	66.7
Verbal versus quantitative orientation**	13.83	13.88	13.85
Level of administrative support*	4.08	4.14	4.11
Adequacy of computer facilities**	14.75	14.12	14.42
Presence of opinion leaders*	3.96	3.81	3.88
Compatability of software with hardware	3.56	3.89	3.73
Could software be used effectively*	3.32	3.75	3.55
Knowledge of computer logic (5 questions)	3.21	3.83	3.54

* 5 point Likert scale
** 20 point Likert scale

criteria. The percentage of computer users correctly identified was 75.9% (only 1.3% higher than the stringent criteria) and the percentage of nonusers correctly identified was 66.8% (only a 0.9% gain). The additional 5 variables did not increase the discrimination between the two groups appreciably. Table 4.5 lists the 15 colleges and the percentage of cases correctly classified for each one. Half of the colleges had a percentage that was similar to the overall percentage. However, three colleges (Danville Community College, Paul D. Camp Community College, and Northern Virginia Community College) had lower correct classification percentages while five colleges (Blue Ridge Community College, Patrick Henry Community College, Central Virginia Community College, Southwest Virginia Community College, and Northern Virginia Community College Annandale Campus) had higher than average percentages. Most of these variant percentages came from colleges with small sample sizes and the differences among the percentages might not be that important. The only large college samples with departures from the overall percentages were from the Northern Virginia Community College campuses and Central Virginia Community College. The size of the individual college samples are generally too low to permit a separate discriminant analysis on each one. The largest college samples are from Thomas Nelson Community College (37), Virginia Highlands Community College (41), and Northern Virginia Community College Annandale Campus (49), but even these numbers are only 2 to 2 1/2 times larger than the number of independent variables. A discriminant analysis was performed on the Northern Virginia Community College Annandale sample and 11 variables were included in the

TABLE 4.5

PERCENTAGE OF CASES CORRECTLY IDENTIFIED
IN THE 15 COLLEGES

College	Percentage
Virginia Highlands CC	69
Danville CC	59
Central Virginia CC	84
Blue Ridge CC	79
Piedmont Virginia CC	74
Patrick Henry CC	91
Rappahannock CC	71
Dabney S. Lancaster CC	71
Paul D. Camp CC	57
Wytheville CC	69
Thomas Nelson CC	70
Virginia Western CC	70
J. Sargeant Reynolds CC	74
Southwest Virginia CC	88
Northern Virginia CC	63
Northern Virginia CC Annandale	75
Overall Average	70.45

discriminant function. Table 4.6 lists these 11 variables in the order of entry and their canonical coefficient. The asterisk indicates the 4 variables that were the same as those in the total sample. The other 7 variables replaced the remaining 5 variables in the larger sample. The percentage of cases correctly identified was 88.5% for computer users, 73.9% for nonusers, and 81.6% overall. Most of the means for the 18 independent variables were similar in the Annandale sample and the total sample. However, 45.6% of the Annandale respondents were male as opposed to 57.1% in the total sample, and there was a greater discrepancy between the two groups in terms of computer training. Specifically, there was less difference between the groups at Annandale (55 hours for nonusers; 99 hours for users) than in the total sample (40 and 136).

Discussion of Results

The research questions as posed earlier, asked whether attributes of the faculty themselves or the academic environment under which the faculty members are working would be the most important in predicting instructional computer use. Of the 7 academic environment variables, 4 were included in the discriminant function and of the 12 faculty attributes measured, 5 were included. Although the first variable to enter was the opportunity to preview software (an environmental variable) 5 of the next 6 variables were faculty attributes (step 2, noninstructional academic computer use; step 3, ownership of a computer; step 5, level of training; step 6, community college teaching experience; and step 7, verbal versus quantitative orientation).

TABLE 4.6

VARIABLES ENTERING AT EACH STEP OF THE DISCRIMINANT ANALYSIS WITH THEIR CANONICAL COEFFICIENT

- Northern Virginia CC Annandale Sample -

Step	Variable	Canonical Coefficient
1	Compatability of software with hardware*	.60133
2	Knowledge of computer logic	.39149
3	Number of different teaching techniques	.33013
4	Opportunity to preview software*	.57204
5	Attitude toward computers	.48112
6	Adequacy of computer facilities	.51495
7	Community college teaching experience*	-1.36494
8	Four year college teaching experience	1.17535
9	Percentage of males	.35811
10	Noninstructional academic computer use*	.40624
11	Level of administrative support	.31529

*discriminating variables in total sample

Usefulenss of the software entered at step 4 and compatability of software with college hardware and presence of opinion leaders were entered last in steps 8 and 9. The results indicate that both types of variables are important but the faculty attribute variables have the advantage because they entered at lower steps in the discriminant analysis.

The possibility exists that the conditions that influence computer use might be different in many of the colleges than the total sample results indicate. In an attempt to uncover discriminating variables in data from 15 separate colleges, perhaps such contradictory information lead to a discriminate function that correctly classified a lower number of cases. When discriminant analysis was run on data from Northern Virginia Community College Annandale Campus, a slightly different set of variables was selected which correctly classified 81% of the cases. The analysis on the Annandale Campus data was based on such a low sample size (49) that the reliability of the analysis is questionable. It points to a possible difference in situation among some of the colleges but is by no means conclusive.

The use of computers by community college faculty in Virginia outside of data processing is very limited. Only 15% of the total faculty had used computers in their instruction on two or more occasions in the past two years. Interestingly, there was a higher percentage of computer users in the smaller community colleges than in the four larger ones. This finding is contrary to the cosmopolitanism aspect of the diffusion theory which assumes that larger urban areas with greater accessibility to technological and educational resources would be quicker to adopt innovations. Why the reverse is true in Virginia is not fully known. Perhaps the larger colleges are more involved with their high number of programs with expensive equipment budgets and with the bureaucracy necessary to keep everything running smoothly. Smaller schools may be free of these restraints and their leaders can be more innovative. Another factor may be that because of improved transportation and communications in late 20th century America, there is not that much difference between rural and urban areas in terms of information availability and technological resources.

Among the smaller schools, Paul D. Camp Community College is known to have a staff member whose sole responsibility is to seek grant money and this has allowed them to purchase a sizable amount of computer hardware and software. Virginia Highlands Community College received funding for two years from the Appalachian Consortium to purchase computer equipment and to hire a programmer to help faculty create programs and instruct them in the uses of the computer. The administrators at Southwest Virginia Community College seem committed to providing enough computer equipment and encouragement so that any faculty member who is interested in using computers will have the necessary expertise and facilities. This committment is evidenced by the fact that the college has more microcomputers for its size than any other college in the system and made more microcomputer purchases with 1984 equipment money than any college except one. The reasons for higher computer usage in the other small to middle sized colleges is not known but would be an interesting topic of investigation.

The literature on computer usage has indicated that the most use has been in mathematics, the sciences, business, and electronics. The situation in Virginia is very similar except that there were fewer computer users in biology than in chemistry or physics. What the high use areas indicate is that the computer is still used primarily as a computational tool. Some simulation programs are used extensively in business, accounting, and to a lesser extent in a variety of the other disciplines. Compared to the traditional uses of computers, word processing is becoming more important in English. Because of the versatility of word processing software, students can type their written assignments on the computer, then edit and print the document. In fact, some faculty outside of the English discipline also have their students use word processing programs for written assignments. Drill and practise, although not a popular computer use among many faculty, is often used by English faculty to reinforce grammar. In drafting and in some engineering courses, several faculty report using CAD (computer aided drafting) and many faculty reported the use of computers to draw graphs (especially in mathematics and some business courses). Not investigated in detail was the use of computers in nursing, allied health, and occupational programs (automotive, air conditioning, printing, machine shop, and hotel/restaurant management).

Eighty-seven percent of the computer users reported that they had an opportunity to preview available software as opposed to 62% of the nonusers. Logic would dictate that computer users would have been able to preview software, but what about the nonusers? Had they previewed software yet not adopted computer use or had they not previewed software at all? Although 62% of the nonusers had previewed software and had for some other reason decided not to use it, there was enough of a difference in response compared to the user group that the variable was the most important one in the discriminant analysis. Interestingly, only 87% of the users had previewed software. Perhaps there could have been a difference in perception of the meaning of the word "preview" but also some computer users reported that they write their own programs or have their students write them.

Over two-thirds of the users (69%) had used computers for word processing, test generation, and calculating and storing student records. Only 43% of nonusers had any noninstructional academic use. Fifty percent of the users owned a microcomputer but only 23% of the nonusers did. These results show that faculty who have used computers outside of the classroom were more likely to use them instructionally. According to the diffusion theory, these variables (including previewing software) are aspects of the "trialability" of an innovation. Potential adopters are more likely to adopt an innovation if they have been able to work with it and see it in operation.

The discriminant analysis indicated that opinions regarding the usefulness of available software was an important discriminating variable. Informally, many nonusers were of the opinion that the "state of the art" in software writing had not progressed far enough and most of the available software was of the drill and practise variety or geared more toward the high school level. They also felt that commercial software did not present the exact course material content that they wanted.

Training is an important adopter characteristic in the diffusion theory since innovations spread very slowly through an untrained social system. Computer users averaged 136 hours of courses, workshops or independent study as opposed to just 39 hours for nonusers. Much of the time reported by users was in independent study outside of formal coursework.

The literature was contradictory as to whether longevity in a teaching position favors or inhibits innovation. In this study of computer usage, community college teaching experience was an important discriminating variable but it made a negative contribution. In other words, computer users on the average had less experience (10.7 years) than nonusers (12.7 years) in community college teaching. With this innovation and in the VCCS, computer users have less teaching experience. Whether this difference is due to rigidity in teaching methods with time is debatable since the difference between the two group means is only two years. The number of years of experience in public schools and in four year colleges was similar for both groups (an average of about 2.5 years in each category). These numbers were rather low and public school teaching, four year college teaching, and total teaching experience were not selected as discriminating variables.

The verbal versus quantitative orientation variable entered later in the discriminant function, so its predictive value is not as important as those that preceeded it. A neutral score on the four verbal - quantitative questions was 12. The mean score of the computer users was 13.88 which was only slightly higher than the 13.83 mean for nonusers and represented a mean that tended toward verbal orientation. This finding is surprising considering that the computer is used so heavily in disciplines requiring computation. On the other hand, word processing is becoming an important tool in English courses and this is affecting the mean score in the direction of verbal orientation. Also, results of the pilot study indicated that occupational and business faculty were not consistently oriented toward either verbal or quantitative extremes as English and science-math faculty were. Occupational and business faculty scores covered a wide range and since this group composed a large proportion of the sample, the mean score would be pulled toward the middle of the scale.

The two lowest variables in terms of discriminative power were compatability of software with hardware and presence of opinion leaders. Computer users responded more positively that the available software would run on their college's computers (3.89 as opposed to 3.56 for nonusers on a 5 point Likert scale). More detailed research is needed to determine the types of microcomputers present at each college. Many schools have Apples, TRS-80's, and IBM PC's which should run most of the available software. There are word processing packages for almost all computer types. Business and accounting seem to use more IBM software and other disciplines are strongly tied to Apple related software. At this point, there is no reliable information as to exactly why nonusers had a greater tendency to report that the software would not run.

The finding that the presence of opinion leaders could be a discriminating variable is not surprising but in this study the variable as measured made a negative contribution. Computer users responded more in disagreement to the statement that there were computer literate expertise at their college (3.81 as opposed to 3.96 for nonusers on a 5 point Likert scale). Also, computer users knew a mean of 12.8 faculty who also used computers which was only slightly more than the mean of 10.2 faculty that the nonuser group was acquainted with. The negative influence of opinion leaders is in contrast to the importance of this variable in the diffusion theory. According to the theory, an opinion leader is a member of the social system who, by using an innovation himself, can influence others in the social system to use it. Diffusion of an innovation would occur faster when there are more opinion leaders in the system. This concept would seem to be perfectly logical in the context of this study since faculty members should be more likely to use computers if they were aware of other faculty who had successfully used them. Therefore it is amazing to find that this is simply not the case with this sample of VCCS faculty. Obviously there are more important considerations in adopting computer use than the fact that one's colleagues are using them.

The preceeding nine variables are important due to their inclusion in the discriminant function. It is also instructive to look at those variables which were not able to discriminate between computer users and nonusers. Forty-one percent of the nonusers were male compared to 49% of the users but this variable was not a discriminator between the groups. Members of both groups felt that the degree of administrative support (4.08 nonusers, 4.13 users on a 5 point scale) and the computer facilities (14.75 nonusers, 14.12 users on a 20 point scale) were adequate. Use of other classroom innovations was not a discriminating variable. Computer users used a mean of 6.8 different methods and nonusers used 6.9. The attitude of faculty members toward computers in both groups was very close (65.2 for nonusers; 68 for users) and also not a discriminating variable.

Actually the failure to find a discriminating factor in innovativeness and attitudes is encouraging! Informal talks with several community college faculty and administrators revealed a prevalent opinion that community college faculty as a group are too conservative and not willing to try different teaching techniques. At worst, they feel that there may be a condition of intellectual laziness and lack of motivation to do their best. However, the results of this study seem to indicate that faculty members who are innovators in terms of computer use do not use any more teaching techniques than their peers who do not use computers. The grand mean of 6.85 different methods indicates that community college faculty use a surprisingly high number of different teaching techniques with their classes.

The fact that community college faculty attitudes toward computers as measured by Ellsworth and Bowman's "Beliefs about Computers" scale are about the same indicates that faculty who do not use computers do not hold a more negative opinion about the technology. In fact, the mean score indicates a highly positive opinion. The neutral score on the scale was 51 and the highest possible positive score was an 85. The faculty mean of 66.7 was relatively high. In comparison, Ellsworth and Bowman's computer science students had a similar mean score of 67.92 which was higher than their general biology students whose mean was 59.97. Since the scale was used in 1982, it is possible that the scores could have been higher in 1986 considering the increased public interest in computer technology. To check this possibility, the attitude scale was given to 2 general biology classes at Tidewater Community College. Thirty students from these classes were in the college age population (18 - 24) that Ellsworth and Bowman used. These community college students were typically employed from 20 to 29 hours per week and carried a credit load of 13-18 quarter hours. In addition to these differences, the community college students were probably less academically prepared than Ellsworth and Bowman's university sample. However, the mean score of the 30 community college students was 61.1 which was only slightly higher than Ellsworth and Bowman's student mean of 59.57. A t-test showed no significant difference between the two means ($t = 1.13$ with 137 degrees of freedom). The conclusion could be made that the mean score for the typical undergraduate college-age student has not changed much since 1982. The community college faculty mean of 66.7 was significantly higher than the students' mean score ($t = 4.7$ with 468 degrees of freedom; $p > .01$). The faculty scores were also higher than the mean score of a sample of older, full-time employed students. Students in several night classes at Tidewater Community College were given the attitude scale and responses were used from 31 students who reported that they were over 25 years of age and were employed full-time. Generally these students carried only 4 to 10 credit hours and were taking classes for retraining, recertification, or to begin their college education while maintaining their present career. They were the closest possible sample to the community college faculty and their major difference was their level of education. The mean score of the group was 62.7 which was lower than the community college faculty mean of 66.7. The difference between the two means was significant at the 1% level (t = 2.5 with 465 degrees of freedom). The mean of the faculty group that did not use computers was not significantly different from the full-time employed group but was significantly higher than the college-age student sample (t = 3.29 with 234 degrees of freedom). These results show a tendency for the faculty to be slightly more positive toward computers than the general population.

CHAPTER V

CONCLUSIONS AND SUMMARY

This research has shown that there are measureable variables relating to community college faculty members or their academic environment which can be used to discriminate between faculty who use computers instructionally and those who do not. Around 70% of the data cases can be accurately classified and the computer users can be identified with greater accuracy than the nonusers. The percentage is somewhat low considering that random assignment to the two groups has a 50% accuracy. However, a preliminary step has been made in the right direction and the results of this study have several definite implications for instructional computer use. As stated previously in Chapter I, a knowledge of which variables are the most important discriminators between computer users and nonusers would be the ones that, if present, could lead one to predict greater computer usage. Some of these variables could not be altered in a direction that would lead to more computer adoption. In this study, nine variables were found to be effective discriminators but four of them (ownership of a computer, verbal versus quantitative orientation, usefulnes of software, and community college teaching experience) could not be manipulated. However, administrators might need to know that computer using faculty tend to have less teaching experience and slightly tend toward verbal orientation as opposed to quantitative. Computer users are also more likely to own their own microcomputer and feel more strongly that the available commercial software is adequate for their courses. The five remaining discriminating variables were opportunity to preview software, noninstructional academic computer use, level of training, compatability of software with hardware, and presence of opinion leaders. Based on these variables, certain suggestions could be made to faculty and administrators regarding ways to increase computer adoption.

Recommendations

The premise behind making recommendations to increase computer adoption lies in the belief that students need to know how to use computer technology. Some research has shown that learning is enhanced with certain computer uses. Also, since students are living in a "computer age", they should be able to understand what the computer can do (and not do) and use one effectively without apprehension. Some students may have a computer at home or have used one in public school but the community college should guarantee that students are exposed to computer use in at least some of the courses that they take. In order to insure that faculty are making effective use of computers in the courses that they teach, the following recommendations are made based on the five variables in this study that can be modified and on two variables that were not important discriminators.

Insure that hardware is compatable with available software. Since most microcomputers are very similar in what they can do, most experts say that one should choose the software that best fits the need and then buy a computer that can run it. One difference between computer users and nonusers in this study was that the nonusers responded more often that the available software would not run on the computers at their college. Community college administrators should try to acquire a number of different microcomputers in order to increase the chances that faculty would be able to run the software that is available. This is not an easy task when certain groups of faculty press to purchase large numbers of computers from one manufacturer such as IBM for business software or Apple for many other disciplines. Preliminary information indicates that some Virginia community colleges already have a variety of microcomputers while others are limited to only a few types.

Provide opportunities to preview software. When the problem of compatability of software and hardware is solved, then the faculty can make maximum use of the opportunity to preview available software and see if it is applicable to the courses that they teach. The strongest variable in discriminating computer users from nonusers was that the users reported more frequently that they had been able to preview available software. Faculty should be encouraged to order software on a trial basis to see if it fits their needs. Most commercial software can be ordered on approval in the same manner as most audio-visual material. Budget policies should be altered as necessary to allow faculty to use this approval purchase option either within the A-V budget or with departmental funds. Faculty may be hesitant to push to order software for preview unless encouraged by administrators and peers or until the bureaucratic red tape to ordering has been streamlined.

Encourage noninstructional computer use. One factor which was important in discriminating computer users from nonusers was that users had more experience with microcomputers. Users often owned a computer and/or used a computer for noninstructional academic uses. Ownership of a computer is difficult to encourage, although some reports in the literature describe programs where colleges would loan microcomputers to administrators for a limited period of time in order for them to get acquainted with using a computer. No reports were found where this type of approach was used with faculty, probably due to the number of faculty and expense involved. However, if the microcomputer facilities at the college are adequate, faculty should be encouraged to use computers for course administration. The college could provide computers for each academic department for faculty use only which would be separate from the computers available for student use. Faculty could be shown that computers are an important time saving tool in course preparation. Handouts for students can be created with word processing software and stored on disks so that a permanent copy is available which can be easily modified in the future as faculty needs, inclinations, or textbooks change. Electronic spreadsheets can be used to store class rolls along with test scores. Any averages or statistical calculations can be performed on the recorded data, stored on disks, and printed for grade posting, reporting, or filing. Most textbook companies have test bank and test generating software. Once test items are stored on disk, they never have to be typed again. Tests can be created and printed using the stored test items and what few new items the instructor might want to add. Stored test items can easily be corrected, modified or updated and most of the software allows the test to be generated in almost any format that the instructor desires.

Increase and encourage opportunities for training. One of the traditional means to increase instructional use of computers is to provide seminars and workshops either as continuing education credit or as professional development. This study indicates that the level of training in computer use is a discriminating variable between computer users and nonusers. Computer users average 136 hours of training and nonusers average only 39 hours. Much of the users' training, however, is in the form of independent study rather than in coursework, seminars, or workshops. Perhaps faculty should be encouraged to learn about computers on their own time, although seminars and workshops can also be employed. If faculty are familiar with the computer facilities on campus and know the in-house experts and instructional computer users, they can make efficient use of their own time. Many faculty seem to react negatively to coursework or organized workshops for whatever reason and could be encouraged to work independently.

Understand that faculty are innovative and have positive computer attitudes. Administrators should be encouraged because this study found no important difference between the two faculty groups in terms of computer attitude or innovativeness. Administrators should accept the idea that if faculty do not use computers it is not because of a negative attitude toward the technology. Other factors are operating that do not involve computer attitudes. Many faculty who do not use computers have made encouraging remarks about this study on their questionnaires and a large proportion of computer users and nonusers (around 225) expressed an interest in receiving copies of the results of the study.

This study also found that Virginia community college faculty are fairly innovative in that they will use a variety of different teaching styles and methods with their classes. Administrators are often lead to believe for whatever reason that many faculty are not willing to attempt new teaching approaches and would rather stay with their traditional methods. Apparantly faculty who do not use computers instructionally should not be accused of being less innovative than their computer using colleagues. Some faculty would rather experiment with certain teaching methods while some of their colleagues experiment with others.

Implications for Further Study

Any educational or scientific research while producing relevant information will also raise questions of it's own and this study is no exception. Omissions are noticed in retrospect and ways that the study could have been improved are discovered but too late to be incorporated.

Since the discriminant analysis achieved an accuracy of 70% in classifying cases correctly, the search for additional measurable variables and better precision for the existing variables should be attempted. Perhaps an important factor that is inhibiting computer use was overlooked originally. Attempts were made during the pilot study to obtain input on other variables that should be included. During the main study, it was not deemed advisable to ask nonusers an open-ended question such as why they did not use computers. This style of questioning might have seemed threatening or too biased and could have caused many nonusers not to return the survey. The problem of inaccurate answers is always a problem in any research survey. Possibilities for error are greatest in the items dealing with adequacy of computer facilities or software and presence of opinion leaders. The wording of these items is still too ambiguous and it is not certain that all respondents interpreted them in exactly the same way.

This study attempted to look at a wide range of possible discriminating variables in a number of colleges in order to get an overall picture of computer usage in the VCCS for which there was no information available. For this reason, detailed information was not collected on specific topics in each college such as administrative support, peer encouragement, types and number of computers present, and kinds of software available for use. A case study of several of the mid-sized or large colleges would provide a better picture of how computer technology is diffusing through the college along with factors that might be encouraging or inhibiting this diffusion. This type of study, although useful, might not be generalizable to other colleges.

As mentioned earlier, there is a possibility that the mechanisms involved in the diffusion of computer use might be slightly different from one college to another. A case study in several selected colleges might indicate whether there are important differences among the schools in terms of diffusion of computer usage. The results of the discriminant analysis in this study was not reliable in this regard because the sample size in most colleges was too low for meaningful comparisons.

A more detailed case study or studies might also clear up two other intriguing questions. One involved the composition of the initial sample which indicated that there was more instructional computer use at smaller or mid-sized colleges than at larger ones. Only speculation exists on the reasons for this observation since no reliable information has been gathered to explain the situation. Another unusual result from the discriminant analysis indicated that the number of opinion leaders that a faculty member knows is not a discriminating variable in this sample. Opinion leaders have always been considered an important aspect in the diffusion of innovations. More research is needed to discover why this does not seem to be true among community college faculty in Virginia.

Summary

Computers are an important aspect of higher education in the late 20th century because of the research that indicates that computers can enhance learning and because in this information based society, citizens will need to know how to use and appreciate computer technology.

Although some efforts have been made to increase the adoption of computers by faculty for classroom use, the technology remains very underutilized in higher education. If the factors which influence faculty to adopt or not adopt instructional computer use were better known, then perhaps some of these factors could be modified in a direction that would increase the level of use. The problem statement for this study questions which characteristics of the community college environment are the best discriminators between faculty who currently use computers in instruction and those who do not. Specific research questions ask whether the "environmental context" of the faculty or individual faculty attributes are better discriminators between computer users and nonusers.

The theory which underlies this study is the diffusion of innovations theory which attempts to explain how innovations are spread from its source through specific communication channels to the members of a social system who will ultimately accept or reject the innovation.

The target population was the full-time faculty employed in the Virginia Community College System. A sample of faculty in 15 colleges was selected in which approximately half had used computers in their instruction. The sample was mailed a questionnaire designed and pilot tested to measure variables which could be used by discriminant analysis to discriminate between computer users and nonusers. These variables included the following environmental context variables: presence of change agents and opinion leaders; adequacy and usefulness of available software; and opportunity to preview software. The attributes associated with the individual faculty member include sex, years of teaching experience, attitude toward computers, innovativeness, knowledge of computer programming, level of training in computer use, verbal versus quantitative orientation, noninstructional academic computer use, and ownership of a microcomputer.

In the useable sample of 446 faculty, 212 were computer users and 234 were not. Conservatively, only 15% of the VCCS faculty had used computers instructionally but the percentage was higher in the smaller schools. The disciplines with the highest number of users were mathematics (38), business (31), accounting (20), English (21), allied health (17), electronics (16), and engineering (13).

The stepwise discriminant analysis revealed 9 variables which when taken as a group would correctly classify 70% of the cases (75% of the computer users). These 9 variables in the order of entry into the discriminant function were: (1) opportunity to preview software; (2) noninstructional academic computer use; (3) ownership of a microcomputer; (4) adequacy of available software; (5) level of training; (6) community college teaching experience; (7) verbal versus quantitative orientation; (8) compatability of software with hardware; and (9) presence of opinion leaders. Variables 6 and 9 made a negative contribution to the function. When the analysis was run on the largest individual college sample, a slightly different set of variables were included leading to the possibility that the diffusion of computer innovations might be somewhat different at each college than the overall results indicate.

In answer to the research questions posed, 4 environmental context variables and 5 faculty attributes were found to be discriminating variables. The 2 kinds of variables were almost equally important but more faculty attribute variables entered at lower steps in the function.

The significance of the results especially as they relate to the diffusion theory are discussed. Also discussed is the observation that faculty computer attitudes and innovativeness are <u>not</u> discriminating variables. Based on the results of this study, 5 recommendations are made that could increase the rate of computer adoption by faculty. They are: (1) insure that hardware is compatable with available software; (2) provide opportunities to preview software; (3) encourage noninstructional computer use; (4) increase and encourage opportunities for training; and (5) understand that faculty are innovative and have positive computer attitudes. Based on the questions that have arisen in the course of this study, suggestions for follow-up research in this subject area are presented.

APPENDIX

COPY OF THE QUESTIONNAIRE USED IN THIS STUDY

SURVEY OF COMPUTER USE IN INSTRUCTION BY VIRGINIA COMMUNITY COLLEGE FACULTY

This survey of Virginia community college faculty is conducted in order to gain information on: (1) the extent to which computers are used to supplement classroom instruction in the colleges and (2) the background that faculty members have in using computers. Your cooperation in this effort would be greatly appreciated. Would you please take time to respond to the following list of questions and statements? A return envelope is provided for your use. Thanks in advance for your help.

FOR QUESTIONS 1 THRU 9, CIRCLE THE NUMBER OF THE APPROPRIATE CHOICE OR PUT THE CORRECT NUMBER IN THE BLANK.

1. In the past 2 years, how often have you asked students to use a computer (MUSIC terminal, microcomputer, or other) as a supplement to classroom instruction in any of your classes or labs?
   (1) none
   (2) once
   (3) 2-5 times
   (4) 5-10 times
   (5) more than 10 times

   If you answered with choice 2, 3, 4, or 5, very briefly describe the computer program(s) that you used.

   ____

   ____

   ____

2. In the past 2 years, have YOU used a computer for non-instructional purposes such as grade computation, preparing/editing handouts, creating tests, etc.? (1) yes (2) no

3. Do you have a microcomputer at home? (1) yes (2) no

4. At your college, how many of your colleagues with which you are personally acquainted, are using computers for instructional purposes in their classes or labs? (do not count computer science or data processing faculty) ______________

5. Have you had an opportunity to preview any computer software that is available for your teaching field? (1) yes (2) no

6. Have you engaged in training or acquired knowledge (through courses, workshops, independent study) about computers or computer use in education? (1) yes (2) no

7. If the answer to #6 is "yes," please give the number of CREDIT HOURS for courses and the number of CLOCK HOURS for workshops, seminars, or independent study, in each of the following computer subject areas.

	course credit hours	workshops seminars (clock hours)	independent study (clock hours)
a. computer use in your discipline	______	______	______
b. business data processing	______	______	______
c. uses of computers in education	______	______	______
d. computer science	______	______	______
e. fundamental computer knowledge (computer literacy)	______	______	______
f. other (please specify)	______	______	______

____

____

8. Which sex are you? (1) male (2) female

9. How many years have you taught full-time in grades K - 12? ______

a community college? ______

other colleges? ______

10. Not including laboratory classes, which of the following teaching methods or techniques have you used at any time in the past 5 years? PLACE A CHECK MARK IN THE BLANK NEXT TO EACH CATEGORY THAT YOU HAVE USED. Please add any methods that you have used that are not on the list.

a. transparencies/Kodachrome slides — a. ______

b. videotapes/movies — b. ______

c. classroom demonstrations — c. ______

d. field trips — d. ______

e. student discussion groups — e. ______

f. term papers/written reports/essays — f. ______

g. lecture — g. ______

h. student self-paced techniques — h. ______

i. student contracted learning — i. ______

j. other methods or approaches (please list) — j. ______

____

____

FOR EACH OF THE FOLLOWING 26 STATEMENTS, CIRCLE THE CHOICE WHICH BEST DESCRIBES YOUR LEVEL OF AGREEMENT OR DISAGREEMENT WITH THE STATEMENT.

SD = strongly disagree
D = disagree
N = neutral (neither agree nor disagree)
A = agree
SA = strongly agree

11.	A person today cannot escape the influence of computers.	SD	D	N	A	SA
12.	Computers are beyond the understanding of the typical person.	SD	D	N	A	SA
13.	Credit rating data banks are a worthwhile use of computers.	SD	D	N	A	SA
14.	Our country would be better off if there were no computers.	SD	D	N	A	SA
15.	Computers make mistakes at least 10% of the time.	SD	D	N	A	SA
16.	Computers are a tool, just like a hammer or lathe.	SD	D	N	A	SA
17.	Computers will improve health care.	SD	D	N	A	SA
18.	Someday, I will have a computer or a computer terminal in my home.	SD	D	N	A	SA
19.	Programmers and operators make mistakes, but computers are, for the most part, error free.	SD	D	N	A	SA
20.	Computers slow down and complicate simple business operations.	SD	D	N	A	SA
21.	Computers will improve law enforcement.	SD	D	N	A	SA
22.	A computer may someday take my job.	SD	D	N	A	SA
23.	Computers isolate people by preventing normal social interactions among users.	SD	D	N	A	SA
24.	It is possible to design computer systems which protect the privacy of data.	SD	D	N	A	SA
25.	Computers will replace low-skill jobs and create jobs needing specialized training.	SD	D	N	A	SA
26.	Computers will improve education.	SD	D	N	A	SA
27.	Computers will create as many jobs as they eliminate.	SD	D	N	A	SA
28.	On standardized tests, I usually scored higher on the verbal sections than on the quantitative sections.	SD	D	N	A	SA
29.	In my college coursework, I was more successful in mathematics and science courses than in English and history courses.	SD	D	N	A	SA
30.	The administration of my college is supportive of computer use in the classroom.	SD	D	N	A	SA
31.	The computing facilities at my college are readily available for use by my students.	SD	D	N	A	SA

32.	The number of MUSIC terminals and microcomputers at this college are adequate for the number of students who need them.	SD	D	N	A	SA
33.	My students are able to get enough help from the staff or student workers in order to do their assignments on the computer.	SD	D	N	A	SA
34.	There are individuals in my college that are experts in computer use and I can get assistance from them whenever I need it.	SD	D	N	A	SA
35.	The location of microcomputers and MUSIC terminals at this college and the times that they are available are adequate for the number of students who need them.	SD	D	N	A	SA
36.	Generally, the software that is available for use in my discipline will run on the microcomputers at this college.	SD	D	N	A	SA
37.	I tend to consider myself as more oriented toward words and ideas than toward numbers and computations.	SD	D	N	A	SA
38.	My academic discipline deals more with analytical or mathematical concepts than verbal or other cognitive concepts.	SD	D	N	A	SA
39.	I could effectively utilize the software on the market in the courses that I teach.	SD	D	N	A	SA

THE LAST FIVE ITEMS ARE MULTIPLE CHOICE QUESTIONS. IF A COMPUTER FOLLOWED THE INSTRUCTIONS IN EACH QUESTION, WHAT WOULD THE FINAL RESULT OR OUTPUT BE? IN THE RIGHT MARGIN NEXT TO THE NUMBER OF THE QUESTION, GIVE THE LETTER OF THE CHOICE THAT YOU THINK WOULD BE CORRECT. IF YOU CAN NOT ANSWER THE QUESTION, WRITE CHOICE E.

40. Choose the correct output for the computer program shown below. 40. ______________

```
10 LET C = 6
20 LET D = 8
30 LET E = C+D+2
40 PRINT E
50 END
```

output
A. 6
B. 14
C. 8
D. 16
E. I don't know

41. Choose the correct output for the computer program shown below. 41. ______________

```
10 LET A = 3
20 LET B = 4
30 LET C = A
40 LET B = C
50 LET A = B
60 PRINT A,B
```

output
A. 3 4
B. 4 3
C. 3 3
D. 4 4
E. I don't know

42. What is the main purpose of the following program 42. ____________

```
10 INPUT A, B, C, D, E
20 LET S = A+B+C+D+E
30 LET M=S/5
40 PRINT S,M
```

A. store A, B, C, D, and E in the computer
B. print the letters S and M
C. print the sum and average of five numbers
D. calculate large sums
E. I don't know

43. When the following program is run, the user enters numbers for A and B. The computer will: 43. ____________

```
10 INPUT A,B
20 LET A = A+B
30 LET B = A-B
40 LET A = A-B
50 PRINT A,B
60 END
```

A. print the 2 input numbers, the smallest first
B. print the 2 input numbers, the largest first
C. print the 2 input numbers in reverse order from the way they were input
D. print the 2 input numbers in the same order as they were input
E. I don't know

44. Choose the correct output for the procedure described below. 44. ____________

1. Arrange the 3 names, Brown, Anderson, and Crane in alphabetical order.
2. Remove the last name from the list.
3. If only one name is left, stop. Otherwise, go on to step 4.
4. Arrange the remaining names in reverse order.
5. Go gack to step 2.

output
A. Anderson, Brown, Crane
B. Brown
C. Anderson, Brown
D. Anderson
E. I don't know

THANK YOU FOR TAKING YOUR TIME TO HELP IN THIS RESEARCH PROJECT. IF YOU WOULD LIKE TO HAVE A COPY OF THE RESULTS OF THIS STUDY, WRITE YOUR NAME AND ADDRESS ON THE BACK OF THE RETURN ENVELOPE OR SEND A SEPARATE LETTER TO: LARRY J. SCOTT, TIDEWATER COMMUNITY COLLEGE, VIRGINIA BEACH, VA 23456.

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Abstract

A STUDY OF THE FACTORS WHICH INFLUENCE COMPUTER ADOPTION BY COMMUNITY COLLEGE FACULTY IN VIRGINIA

Larry Joe Scott, Ed.D.

The College of William and Mary in Virginia, June, 1986

Chairman: Professor Armand J. Galfo

The problem statement for this study asks which characteristics of the community college environment are the best discriminators between faculty who currently use computers in instruction and those who do not. Specific research questions ask whether the environmental context of the faculty or individual faculty attributes are better discriminators between computer users and nonusers.

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In answer to the research questions posed, 4 environmental context and 5 faculty attributes were found to be discriminating variables. The 2 kinds of variables are almost equally important but more faculty attribute variables entered at lower steps in the function. Based on these results, 5 recommendations are made that could increase the rate of computer adoption by faculty: (1) insure that hardware is compatable with available software; (2) provide opportunities to preview software; (3) encourage noninstructional computer use; (4) increase and encourage opportunities for training; (5) understand that faculty are innovative and have positive computer attitudes.