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An analysis of the relationships between selected variables and the adoption and diffusion of computers for instructional purposes among community college faculty

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An analysis of the relationships between selected variables and the adoption and diffusion of computers for instructional purposes among community college faculty

by

Dennis U. Anderson

A Dissertation Submitted to the
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CHAPTER I. INTRODUCTION

Successful introduction of a technological innovation depends on both individual and organizational acceptance of the innovation. The degree of acceptance effects the rate at which the innovation is adopted. The acceptance and rate of adoption of the innovation, according to Bright (1968) and Rogers and Shoemaker (1971), depend on its characteristics. These characteristics include: (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability, and (e) observability. Relative advantage is the degree to which the innovation is viewed to provide greater service, satisfaction or economy to users than does its present equivalent. Compatibility is the degree to which the innovation is perceived as being consistent with existing values, past experiences and the needs of users. Complexity is the degree to which an innovation is perceived as difficult to use or understand. Trialability is the degree to which an innovation may be experimented with on a limited basis. Observability is the degree to which the results of an innovation are visible to others. Innovations may be abandoned or delayed due to organizational and personal resistance (Katz et al., 1980). While there may be a universe of variables contributing to the process of adoption, this study is limited to selected variables which were primarily identified by Rogers. Clayton (1979) stated that "progress is being made" in the effective application of technological resources to educational problems. Nevertheless, well-meaning efforts to use technology by educators can result in costly errors if the nature of

the technology is misunderstood.

Rogers and Shoemaker (1971) described five categories of people based on innovativeness: innovators, early adopters, early and late majority, and laggards. They examined the findings of over 3,000 studies which related independent variables to innovativeness. They found significant differences in adopter characteristics among the categories in the areas of socioeconomic, personality, and communication behavior. They also determined value differences among members of these categories. Innovators were considered venturesome, early adopters were considered respectable opinion leaders, early majority adopters were considered to be deliberate, the late majority were considered skeptical, and the laggards were traditionally oriented.

Although the computer was created on a university campus and commercial computers have been available since 1951, there has been and continues to be a resistance to the adoption and diffusion of computers in the instructional process (Babb, 1982). Several authors (Richards, 1974; Purdy, 1975; Clayton, 1979; Rose, 1982; Duttweiler, 1983) have identified inhibitors or barriers to the adoption of educational technology. These inhibitors vary in type and degree but have been classified by Rose (1982) into: (a) institutional economic barriers, (b) technological barriers, (c) institutional administrative barriers, and (d) educator barriers. Economic barriers refer to unavailable money and resources needed to fund new technologies. Technical barriers include the complexity, availability, relative advantage, compatibility, trialability, observability, and accessibility of the innovation.

Administrative barriers refer primarily to the degree of administrative encouragement, support and rewards given to innovators. Finally, educator barriers include the degree of resistance to technical change through perceptions of self, values, biases, and teaching philosophies. Any or all four of these barrier classifications may be real or perceived as real by the educator.

In addition to the definition and classification of barriers to the use of technological innovation, several theories of resistance to change have been proposed. One of these theories states that faculty are inherently resistant to any teaching practice which is new to them whether it uses technology or not (Rose, 1982). Other theories hold that change evolves within a total social system or from adaptation to forces outside of the system (Watson, 1966). Rogers and Shoemaker (1971) and Zaltman et al. (1973) also suggested that innovation depends on both individuals and the social organization within which it functions. There may be a wide range of possible reasons for the success or failure of adoption of a technological innovation. Therefore, these theories of change and related variables of resistance imply that one should examine both individual and organizational variables as potential constraints prior to initiating changes in an organization. Furthermore, Rogers and Shoemaker (1971) have demonstrated that innovations tend to flow upward within the organizational hierarchy of a bureaucracy. In a college environment, this would suggest that faculty and their immediate work environment play key roles in the adoption of educational innovation.

An innovation, such as the use of a computer for instructional

purposes, is used here as an idea perceived as new by the educator or the college as an organization. In order to encourage or discourage the use of computers, it is relevant for educators to understand the process of and the variables related to the adoption and diffusion of technical innovation. The reasons for resistance as well as the theories of change and innovation will be reviewed in greater detail in Chapter II.

Statement of the Problem

In 1967, the Pierce Report concluded that in spite of many recent predictions that educational technology would revolutionize instruction in higher education, it had not yet occurred. In 1981, the Panel in Computing and Higher Education (Gillespie) stated that computing in higher education was an "accidental revolution, still growing wildly, and still in its infancy." In 1982, the Congressional Office of Technology Assessment argued that information technology could be invaluable for education if it was only properly employed. In 1983, Duttweiler concluded from a review of the literature that there were very few examples where the application of computer technology had improved educational productivity. It would appear, therefore, that educators are not using the available instructional technologies as readily as they could (Rose, 1982). Numerous investigators (Walker, 1981; Zaltman et al., 1973; Rose, 1982; Evans, 1968; Duttweiler, 1983; Clayton, 1979) have demonstrated or concluded that barriers or inhibitors of varying origins prevent the adoption and diffusion of innovation for instructional planning and use.

This study described the relationships that exist between perceived faculty barriers and the degree to which they influence the adoption and diffusion of computers for instructional purposes in higher education.

Purpose of the Study

The purpose of the study was to identify the relationships between selected computer practices, perceived faculty barriers, and the adoption and diffusion of computers for instructional purposes among community college faculty. The barriers to adoption and diffusion examined were defined according to Rose's (1982) four general categories. Adoption areas were based on the intensity with which faculty used each of the selected practices and the average dates which the adoption began. These areas described the intensity of adoption as opposed to those defined by Rogers and Shoemaker (1971) which classified adopters in a range of categories between innovators and laggards.

Objectives of the Study

The objectives of the study were:

1. To describe faculty computer usage practices and the degree of adoption of these practices.
2. To describe the factors that are perceived to either facilitate or serve as barriers to the adoption and diffusion of computers for instructional purposes.
3. To examine the interrelationships among the factors that affect the adoption and diffusion of computers for instructional purposes.
4. To examine the relationships between perceived factors and faculty

computer practices.

5. To describe areas of faculty intensity of adoption from the self-reported computer usage practices.

Hypotheses Tested

After faculty intensity of adoption areas were determined from the faculty computer practices data, the following hypotheses were tested:

1. There is no significant relationship between perceived institutional economic barriers and faculty adoption.
2. There is no significant relationship between perceived technical barriers and faculty adoption.
3. There is no significant relationship between perceived administrative barriers and faculty adoption.
4. There is no significant relationship between perceived educator barriers and faculty adoption.
5. There is no significant relationship between sex (gender) and all measures of faculty adoption or educational perceived barriers.
6. There is no significant relationship between age and all measures of faculty adoption or educational perceived barriers.

Sources of Data

A survey instrument was designed and used to gather information about faculty computer practices and their perception of possible barriers related to the adoption of computers for instructional purposes. The instrument questions were composed by the author after a review of

selected literature. The research of Rose (1982) and Rogers and Shoemaker (1971) served as the primary guidelines for the creation of individual questions. The survey was reviewed three times for clarity, internal consistency, and readability by a panel of six experts in the field of community college education. Three of these people had received their Ph.D. degrees in the field of education, and the remaining three held master's degrees in their field of interest. Two of the members were community college administrators, and the other four were community college faculty members. Care was taken to administer the survey at an appropriate time of the school year when no unusual events were occurring. Information was collected about 24 computer practices and 18 barrier perceptions. Surveys were distributed to all faculty currently working as full-time faculty in a large metropolitan community college district during the Fall semester, 1983. Five hundred thirty-five surveys were mailed, and 305 of them were returned. This represented a response of 57 percent.

Treatment of Data

Frequency statistics were obtained for all faculty computer practices, sources of technological information, personal data, and perceptions regarding potential barriers to the adoption of computers for instructional purposes. The areas of information sources, computer practices, and perceived barriers were examined using factor analysis in order to determine clusters of related variables. In addition, the researcher described some clusters of variables based on logic and

examination of the data. Reliability coefficients were calculated for each cluster, and only those with coefficients greater than 0.6 were considered for further analysis. The clusters were then compared to each other and the independent variables of age and sex through the use of Pearson's correlation, T-test, one-way analysis of variance, and multiple regression in order to ascertain relationships. The Scheffé and Duncan post hoc tests were also calculated to test for differences between means. This process, described in Chapter 3, was completed in an orderly manner to test the stated hypotheses.

Assumptions of the Study

It was assumed that the survey instrument was administered at a "typical" time of the school year when no unusual events were scheduled that might cause a skewing of the data. The researcher has also assumed that the rate of adoption of an innovation is based on real and explainable variables. The classification structure of these resistance variables (Rose, 1982) was assumed to have logical merit but required further investigation. It was also assumed that intensity of adoption areas could be defined from an examination of faculty computer practices. If perceived resistance barriers could be identified and/or clustered, as Rose ascertained, and areas of adoption could be identified through computer practices, then it was assumed that variable relationships could be determined. Finally, although this study was conducted at a given point in time, it has been assumed that the

hypotheses test results and identified relationships could be repeated in the future.

The following assumptions for statistical analysis have been met in the data collected for this study:

1. The data collected were based on a random and independent sample of community college faculty.
2. The non-respondents were similar to respondents.
3. Computations of correlation coefficients were based on linear relationships between variables.
4. The dependent variables for the analysis of variance tests assured independent samples from normally distributed populations.

Limitations of the Study

The study is limited by the choice of variables to be used in the analysis. It is limited to faculty at a large metropolitan community college system, and the results should be interpreted in terms of the geographical location and size of the sample. Additionally, the data validity and reliability were dependent upon the validity and reliability of the survey instrument.

Definition of Terms

1. A change agent is a professional educator whose primary responsibility is to influence innovative decisions in a way deemed positive by the educational organization (Rogers et al., 1971).
2. The instructional process is defined as the use of computer assisted instruction (CAI) or computer managed instruction (CMI) for

classroom and educational purposes.

3. Awareness is the degree to which an individual knows of a new idea but lacks information about it (Rogers et al., 1971).
4. Interest is the point at which an individual seeks more information about an idea (Rogers et al., 1971).
5. Evaluation is the process whereby an individual makes a decision to try a new idea (Rogers et al., 1971).
6. Trial is the process whereby an individual actually tries or tests an innovation on a small scale (Rogers et al., 1971).
7. Adoption is the process whereby an individual uses a new practice on a full scale and incorporates it into the daily instructional process (Rogers et al., 1971).
8. Faculty computer practices are the degree of involvement or association a faculty member has with computers. Examples of these practices include the number of computer journals subscribed to, the number of computer classes taken for college credit, the number of computer staff development workshops attended, the ownership of a personal microcomputer, and the amount of time spent using a computer.
9. Institutional economic barriers are faculty perceptions about the monies available for computer instructional purposes, the urgency of need to make monies available, and the willingness of educational institutions to make an on-going financial commitment for hardware, software and personnel (Rose, 1982).
10. Technical barriers are faculty perceptions about the use of the

computer itself for instructional purposes. These barriers include relative advantage, compatibility, complexity, trialability, and observability (Rose, 1982).

11. Institutional barriers are faculty perceptions of the attitudes of administrative leaders towards the use of computers, the role of the change agent, the decision-making process, the need for systematic planning and incentives for faculty initiative (Rose, 1982).
12. Educator barriers are faculty perceptions based on their own beliefs, philosophies, biases, and personal needs about the innovation and the processes needed to adopt the innovation (Rose, 1982).
13. Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers et al., 1971).
14. Compatibility is the degree to which an innovation is perceived as consistent with existing values, past experiences, and needs of receivers (Rogers et al., 1971).
15. Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use (Rogers et al., 1971).
16. Trialability is the degree to which an innovation may be experimented with on a limited basis (Rogers et al., 1971).
17. Observability is the degree to which the results of an innovation are visible to others (Rogers et al., 1971).
18. Diffusion is a special type of communication process by which an innovation is spread to members of a social system. Diffusion studies are concerned with messages that are new ideas, whereas

communication studies encompass all types of messages (Rogers et al., 1971).

19. The rate of adoption is the relative speed with which an innovation is adopted by members of a social system. This rate is usually measured by a length of time required for a certain percentage of the members of the system to adopt an innovation. Therefore, this rate is based on a group unit of measure, rather than an individual (Rogers et al., 1971).

20. Bureaucratic refers to the decisions which are made in a rational, formalistic way by the appropriate persons within a defined hierarchical structure (Levine, 1980).

21. Collegial decisions are those made in shared fashion with the community of professionals that comprise a college (Levine, 1980).

22. Political decisions are made through negotiation and compromise among power blocs who have the power to restrict formal authority (Levine, 1980).

23. Pluralistic decisions are those which require the interaction of more than one person or department for successful implementation (Nordvall, 1982).

24. Vertically fragmented systems are those which require the interaction of more than one level within an organizational structure to implement decisions (Lindquist, 1974).

25. Intensity of adoption is the degree, amount, or extent to which a faculty member has used or adopted a particular practice.

26. Horizontal governance refers to the need for consensus by various

committees within an institution of higher education in order to enact a decision (Lindquist, 1974).

Significance of the Study

The introduction of computers into the higher education instructional process has been so unplanned that Robert Gillespie (1981) has termed it an "accidental revolution". Purdy (1975) believed that faculty involvement with new technologies in their teaching is a topic of continuing importance. The identification of faculty perceptions that are related to the adoption and diffusion of computers for instructional purposes is important if one wishes to alter the rate of adoption. Also, the identification of barriers which hinder teachers' openness toward changing their teaching practices is important if one wishes to encourage innovation.

This study provides an educational research basis for aiding the planning process. Educational change agents may use this information when planning the procedures for integration of computers into the instructional process. If one can determine some of the differences between faculty who will adopt computers for classroom usage and those who will not, then one has helped determine the framework within which adoption and diffusion can occur. Ultimately, this can help reduce the time-lag period.

Educational administrators, through repetition of this study, can monitor their effectiveness or degree to which they encourage or hinder innovation. The results of this study may also have implications for

faculty staff development programs because the success of reaching various audiences requires an understanding of the perceived barriers and the level of awareness at which individuals can operate. Knowledge of differences of levels can better allow staff development leaders and change agents to design meaningful educational programs.

CHAPTER II. REVIEW OF THE LITERATURE

Introduction

This review of selected literature describes research pertinent to the concepts of adoption and diffusion of technological innovation. Part I examines selected research relating to adoption and diffusion in order to identify the factors contributing to individual and organizational resistance to change. Its purpose is to describe those variables found to affect the failure of innovations. Part II examines selected models and theories of change which explain the process of adoption and diffusion of innovation. Part III examines selected research on theories of change that have specifically applied to the adoption and diffusion of innovation in educational organizations. Parts II and III are intended to describe those variables found to effect how educational change is facilitated. Parts I, II, and III each conclude with brief summaries. Part IV summarizes those theories, models and variables found in the literature which have guided the conceptual framework for this study.

Part I: Studies of Resistance to Innovation

Change in education is shaped by a number of forces, some of which facilitate and some of which impede the progress of an innovation. According to Watson (1966), all of the forces which contribute to stability in personality or in social systems can be perceived as resistors to change. During the life of a typical innovation, perceived resistance moves through a cycle (Lewin, 1951). During the early stage, resistance is massive and widespread. The second stage is identified by

arguments which are both favorable and unfavorable. Direct conflict and mobilization of the forces of resistance occur during the third stage which are often critical to the survival of the innovation. The fourth stage is marked by persisting or stubborn resistance. A fifth and final stage is marked by successful innovation adoption, and finds only a few residual adversaries of the innovation remaining. These forces and cycles of resistance as identified and examined in selected prior research is described in the paragraphs which follow.

General considerations

In colleges, the lecture with discussion is a primary format and method of instruction. Cronklin (1978) concluded from a case study at a large, private university in the Northeast, that any method which moves away from this situation may be perceived as nonstandard by the academic community. The university studied by Cronklin had successfully introduced a new course in sociology using computer-assisted instruction. However, when the instructor left the university, a replacement could not be found to teach the course using computer-assisted instruction in spite of the fact that the computer-assisted class had effectively raised the student learning curves. If Cronklin's conclusion is appropriate to other academic settings, then the implementation of any academic innovation must be considered in light of the variables to the resistance of change and theories of the change process.

Resistance to technological innovations may stem from an individual, a firm, a community, an industry or an institution, such as a school or

college (Bright, 1968). A complete analysis of the process of the adoption of technological innovations is beyond the scope of this study. It depends upon many things, such as economic, cultural, technological, political, social factors, and the ability of change agents to influence environmental forces and trends. Resistance may be widespread within an institution or be centered in an individual or a small departmental group. The benefits of the innovation have been shown to have little relationship with its rate of adoption and diffusion. Research indicates that innovations do not seem to be so eagerly sought out or welcomed when the intended users of the innovation are satisfied or attached to the status quo (Lindquist, 1978). What makes this change in the teaching-learning functions of higher education so difficult? Lindquist suggested that educators needed to perceive a "performance gap". He defined this gap as the difference between what educators think the institution should be doing and what they believe it is actually doing. Unless educators perceive the existence of a wide gap, they are not likely to experiment with or adopt an innovation.

Although persons in universities often attribute change to relatively local and personal events (Hefferlin, 1969), reform in higher education usually comes from the impact of external forces (Lindquist, 1978). However, the failure of educational institutions to change without external pressure is primarily due to the resistance to change by both individuals and organizational units (Nordvall, 1982).

James Bright (1968) conducted an extensive review of the literature on resistance to technological innovation and he deduced that there were

twelve reasons why innovations are opposed by the general public. These were:

> (1) to protect social status or prerogative, (2) to protect an existing way of life, (3) to prevent devaluation of capital invested in an existing facility, or in a supporting facility or service, (4) to prevent a reduction of livelihood because the innovation would devalue the knowledge or skill presently required, (5) to prevent the elimination of a job or profession, (6) to avoid expenditures such as the cost of replacing existing equipment, or of renovating and modifying existing systems to accommodate or to compete with the innovation, (7) because the innovation opposes social customs, fashions and tastes, and the habits of life, (8) because the innovation conflicts with existing laws, (9) because of rigidity inherent in large or bureaucratic organizations, (10) because of personality, habit, fear, equilibrium between individuals or institutions, status, and similar social and psychological considerations, (11) because of a tendency of organized groups to force conformity, and (12) because of reluctance of an individual or group to disturb the equilibrium of society or the business atmosphere.

These twelve reasons imply factors of resistance to innovation which are irrespective of either individuals or organizations.

This section has focused on the fact that resistance to innovation or change is broad in nature. There appears to be an unknown entity which is inherently resistant to change and cannot be solely attributed to individuals or organizations.

Resistance to change in individuals

Goodwin Watson (1966) summarized the research efforts and deductions of 28 researchers on resistance to technological innovation. He emphasized in his review the nature of individual resistance to change. He related individual resistance to personality and categorized it into several components:

1. Homeostasis--This term describes the natural stabilizing forces

within organisms. This concept implies that humans are naturally complacent unless disturbed by intrusive stimuli.

2. Habit--Most learning theory has included the assumption that unless the situation changes noticeably, organisms will continue to respond in their accustomed way.
3. Primacy--The way in which organisms first successfully cope with a situation sets a pattern which is usually persistent. Teachers continue to teach as they were originally taught.
4. Selective Perception and Retention--Once an attitude has been established, a person responds to other suggestions within the framework of his/her established outlook. Situations may be perceived as reinforcing when they are actually dissonant.
5. Dependence--Behavior is similar to ways of behavior that were established by people when they were children.
6. Superego--The superego is a powerful agent serving tradition due to the enforcement standards acquired in childhood.
7. Self-distrust--Children are taught to distrust their own impulses and this carries forward to adulthood.
8. Insecurity and Repression--There is a natural tendency to seek the security of the past.

Watson's research is pertinent to this study because it demonstrates the importance of psychological factors, such as individual perceptions, toward the adoption of change.

Purdy (1975) surveyed 225 faculty in a California community college in 1975 in order to better understand faculty attitudes toward technology

and media used in teaching. He concluded that many educators are "inherently resistant" and do not care to learn about modern technology. He also concluded that a majority of the faculty considered teaching as a solo activity, and had felt a need to manage and direct learning situations as completely as possible. A majority of the educators he surveyed felt that deciding what should go into a course and enacting that plan is a personal and individual challenge. In his summation, he concluded that educators who preferred privacy in teaching and "hands-on" involvement hesitate to use the new technologies and are not likely to be receptive to the adoption and diffusion of nontraditional systems.

Rose (1982) concluded from her review of the literature that educators may lack an understanding of the nature of technology, the philosophical assumptions underlying its use, and its relevance to objectives and learning outcomes. They may not know how to use the technology and/or perceive it as difficult and complex. Furthermore, they may lack the information to enable them to make sound educational decisions. Technology is often perceived by educators as a threat to their jobs. There is an overriding fear that they may have to undergo a radical role change. Educators may also experience conflict between their ideals and self-interest. For example, an educator may feel that students learn more in a nontraditional system, but he or she enjoys the traditional method better. Educational technologies often require a generous commitment of time for the development of nontraditional programs, and this factor may deter educators from using alternative systems. Educators generally need the advice of specialists and in such

a relationship educators create expectations of rapid production. However, when this doesn't occur, educators may become disillusioned. In this situation, they are reluctant to ask for additional help because such a request implies that they are incompetent.

Rose (1982) also concluded from her review of the literature that educators rely heavily on their personalities to direct the learning situation. The fewer the intervening objects between the teacher and the student, the better. Educators with these attitudes perceived instructional technology as impersonal and are often reluctant to use them. An associated concern that educators may have is that learning to run the devices may leave them vulnerable to humiliation. Personal control guarantees order and, thus, the self-respect necessary to function as an educator.

Although low cost microcomputer systems have made computer technologies available to unprepared educators (Huntington, 1981), educators are reluctant to learn about computer-based educational systems due to a significant "training gap." New teachers are graduated each year with no computer-based educational experience or training. While Lindquist (1978) discussed the need for a wide "performance gap" to motivate educators' desire to change, a wide "training gap" may have the opposite effect. In the circumstances surrounding the adoption and use of computers, it appears that a significant perception for a need to change can be nullified by the requirements necessary for implementation of that change.

After reviewing selected literature on technological innovation,

Champion (1975) deduced several potential sources of individual resistance to change. They were: (1) Change can be a threat to job security and creates anxiety for many employees. (2) Change may alter informal group relationships on the job. Educators are likely to resist changes which could be interpreted as potentially disruptive of such associations. (3) Learning to do a new job required by the innovation may be regarded by educators with hostility. (4) General ignorance about the nature and extent of impending change will likely create resistance. (5) Change may signify a loss of status and prestige. Few people want to relinquish their perceived rank in the hierarchy of authority. (6) Some people just don't like to change, regardless of the benefits. (7) Hostility may exist towards any agent of change if he is viewed as an outsider. (8) If there is a clear distinction between staff and faculty within the institution, there may be faculty resistance, especially if innovative change is introduced by a member of the staff. Champion's deductions imply that individual resistance may be closely related to the degree to which change threatens the psychological make-up of individuals.

Resistance to change among faculty members can also be viewed as an example of professionals' general conservatism, which favors traditional methods (Evans, 1968). Additionally, unlike most other professions, faculty as students have all extensively observed role models of the profession. In their graduate training, college teachers rarely receive training in teaching methods that might modify the effect of their role models (Gaff, 1978). Adoption of ideas used elsewhere, such as business

or industry, can be seen as an admission that teaching is a standardized task that can be made more efficient through the use of exemplary procedures. For some faculty, this makes teaching too much like an industrial process and may create skeptical resistance (Hefferlin, 1969). In addition, the willingness to change may be inhibited by general pessimism among faculty at any given point in time in light of the uncertainties which continually face higher education (Gaff, 1978).

The above comments regarding individual resistance to change might lead to the belief that faculty are never willing to respond positively toward technological innovation. Under what circumstances are faculty willing to adopt innovation? The research reviewed here indicates that removal of the identified barriers to change will increase the acceptance of technical innovation. In addition, Watson (1966) made the following ten generalizations based on his review of the literature. Faculty resistance towards innovation will decrease if: (1) educational leaders and faculty feel that the innovation is their own and not solely developed by outsiders; (2) the innovation has the support of top administrators; (3) the innovation is perceived as reducing their present burdens; (4) the innovation is compatible with their personal values and ideals; (5) the innovation offers an exciting challenge; (6) the innovation does not threaten their security; (7) the innovation is not forced upon them without their preview and consent; (8) change agents take steps to reduce fears of the unknown; (9) faculty opinions regarding revisional procedures are considered; and (10) faculty can experience support from each other.

The research presented in this section has demonstrated that factors of resistance to change do exist within individuals. Some variables of resistance such as homeostasis, habit, superego and insecurity appear to be common to all individuals. There are also resistance variables within individuals that may be unique to situations such as the adoption of computers for classroom usage. One of the objectives of this study was to identify and examine the relationships between variables which may influence the acceptance or rejection of technological innovation.

Resistance to change in organizations

One surveyor of the change process attributed the following quote to Freud: "Trying to change a university is like rearranging a cemetery" (Hall, 1979). Colleges and universities seem to be deliberately structured to prevent precipitous change because the power to implement academic decisions is pluralistic (Nordvall, 1982). In addition, the educational system is vertically fragmented and at least partially controlled by a system of horizontal governance. Vertical fragmentation refers to the lack of clearly identified lines of command from top to bottom within an educational institution. Horizontal governance is the term applied to the organizational structures, such as faculty or departmental committees which function as autonomous units and may actually maintain functional control of the administration at multiple levels. Regarding the fragmentation of structure, Lindquist (1974) stated that in the college or university community, there is the division of students, faculty, and administration. These groups are subsequently

divided into smaller groups: departments, living units, offices, etc. Faculty are also divided by discipline, and divisions are often divided by location. The result is a less homogeneous entity within which change can occur. The implication by Lindquist is that change is more likely to occur within a homogeneous organization.

Duttweiler (1983) examined research on change and concluded that the traditional governing structure of education creates greater resistance to innovation than does faculty resistance. Teachers' organizations cannot be expected to favorably approve any proposal that might reduce the number of professional certified teachers in a system. The use of paraprofessionals to monitor classrooms in which content is being delivered electronically will meet with resistance. Accreditation standards, state department of education regulations, and rules governing textbook selection and graduation have all been developed and implemented to provide students with some assurance of an adequate education. These same standards, rules and regulations, however, may also prove to be barriers to the optimum use of educational technology.

According to a study of 110 colleges and universities by Hefferlin (1969), innovation is more likely to occur in some types of organizations than others. He found that organizations which had greater instability (more frequent changes in leadership, staff, and faculty) were more likely to adopt innovation than more rigid organizations. Academic reform was also more prevalent at institutions with changing faculties, low rates of tenure, influential junior faculty, rotating department chairpersons, and educational leaders more oriented toward change.

Colleges located in metropolitan areas also exhibited less resistance to change. Hefferlin's (1969) work was unique in that he proposed a series of barriers which were specific and unique to institutions of higher education as organizations. These seven barriers included: (1) Their purposes and support are basically conservative. Therefore, universities are not especially compatible with innovation. (2) Educational institutions are horizontally fragmented, which means that the modification of programs beyond accepted "boundaries" would be risky. Consequently, universities might be described as organizations with a very narrow range of acceptable norms, values, and goals. (3) The accepted roads to academic prestige and advancement are considered a rather unprofitable endeavor. (4) Because faculty members have observed their vocation for years as students, innovation, therefore, runs against tradition. (5) The ideology of the academic profession treats professors as independent professionals. This means less chance for agreement among educators and between departments. (6) Common needs are hard to demonstrate because educational institutions are skeptical about the idea of efficiency. (7) Procedures for approving change have deliberately been made elaborate and slow through the use of required consensus among committees at multiple levels of the organizational structure. Hefferlin's research implies that variables of resistance to change within educational institutions may be unique and, therefore, different from those found in other organizations.

Hage et al. (1970) reviewed selected research on business organizational structures and derived a set of principal organizational

factors said to influence the degree of resistance to change within an organization. The existing research supports their work insofar as it is taken to refer to general tendencies for change or innovation (Levine, 1973). However, the factors proposed by Hage and Aiken do not necessarily apply throughout the innovation process (Zaltman et al., 1973). These factors are: (1) The greater the degree of codification of jobs, the greater the number of rules specifying what is to be done, and the more strictly rules are enforced, the lower the rate of organizational change. (2) The greater the number of occupational specialties in an organization, and the greater the degree of professionalism of each, the greater the rate of organizational change. (3) The smaller the proportion of unique jobs and occupations that participate in decision-making, the lower the rate of organizational change. (4) The greater the disparity in rewards; i.e., salaries, the lower the rate of organizational change. (5) The higher the volume of production in quantity, the lower the rate of organizational change. (6) The greater the emphasis on efficiency, the lower the rate of organizational change. (7) Higher job satisfaction within the organization creates a greater rate of change. Although Hage and Aiken studied business organizations, the factors they identified may have application to the study of change within higher education.

Levine (1980) reviewed over 75 articles on why innovation fails and concluded that organizational character, the total complexion of a particular organization, is related to the degree of innovation resistance. First, the character of a specific organization is a product

of its history and various organizational types of which it is composed. These decision-making types are bureaucratic, anomic, collegial, and political. The bureaucratic type makes decisions in a rational manner by the appropriate people who have been defined by the hierarchical structure. The anomic type makes decisions through semiautonomous units without resorting to institution-wide norms. Collegial decisions are made in shared fashion by professionals that comprise the college. Political decisions are made through negotiation and compromise among power blocs. The mix of types in a particular institution will vary with time, circumstance, and organizational mission. As this organizational character changes, so does the innovation resisting character. For example, collegial organizations build in a high level of resistance because its decision-making process depends on consensus. Consequently, all or most people must agree to adopt an innovation. Second, given a mix of organizational types within an organization, it is likely that innovation resistance will vary throughout the organization. Therefore, an organization is not a monolithic whole. Standards of compatibility may vary which means that innovation resistance will also vary within the organization.

In 1982, Rose reviewed literature on resistance to innovation and concluded that educational technology influences who determines content, standardization and choice in instruction; quantity and quality of instruction; who designs, produces, and evaluates instruction; and who interacts with and assesses learners. With these thoughts in mind, Rose classified institutional barriers as either economic or administrative.

Institutional economic barriers included: (1) the real lack of money; (2) the allocation of monies in areas other than educational technology because the need to fund innovation was not recognized; and (3) an unwillingness to make an ongoing commitment of resources which are usually required by nontraditional programs. Institutional administrative barriers included: (1) the overselling of a finished product without emphasizing the required efforts; (2) equipment investment costs have encouraged an attitude of "forced use" upon the faculty; (3) the failure to support, appreciate, or reward innovative users; (4) a lack of systematic control or evaluation of usage results; (5) a lack of plans for the use of nontraditional technologies; (6) a lack of definition for the role of technology specialists; (7) a lack of leadership to identify the role of educational technology and the establishment of channels for the diffusion of innovation.

Summary: Part I

Research reviewed here indicated that change in education is a result of many factors, some of which resist and some of which facilitate the process of innovation. Resistance to technological innovations may be the result of variables related to individuals or to organizations. Resistance to change by individuals was found to be related to personality, fears, inherent factors, job security, perceptions of roles, philosophies or methods of teaching, the nature of the innovation itself, and perceptions of the institution. Resistance to change by organizations was related to the type of governance, functional power

units, stability of the organization, organizational character, the extent of the change application, and institutional goals. Thus, the studies in this section have identified many of the factors and variables which may contribute in varying degrees to the adoption or nonadoption of technical innovation.

Part II: Theories of Change

No single, comprehensive theory of how change takes place within higher education was identified in the selected literature reviewed. Theories of the change process draw from both research about change and research about the diffusion of innovation. The theories discussed in this section represent the major research on change as summarized primarily by Lindquist (1978) and Nordvall (1982). Both of these authors based their conclusions on reviews of the change literature. The word "change," for the purpose of model discussions, refers only to "planned" change, and the reader should assume that "change" is different from "innovation" because not all change involves innovation. The term "innovation" as used in this study does not require "planned change." An "innovator" of computer technology is an early adopter regardless of the reason. The theories of change discussed are (1) research, development and diffusion (rational planning), (2) human problem solving, (3) social interaction, (4) political, and (5) linkage.

Research, development and diffusion

This theory is sometimes called a rational planning model because it assumes the application of a rational process (research and development)

in order to attain a rational end. The emphasis is on developing an idea and presenting it in a convincing way. The theory does not seek to change the people or the structure of an organization. The theory is based upon the basic assumptions of scientific research. These assumptions assume: (1) that there is a rational sequence for applying and evaluating an innovation; (2) that the development of an innovation requires long-term planning and coordination of labor among the developers; (3) that the long-term development process is justified by the quality of the innovation; and (4) that the innovation will be presented to a passive rational consumer. The implication is that if the research is correct, and the development is sound, then the proposed change will sell itself (Lindquist, 1978).

The process begins with basic and applied research, hypothesis building, designing of the alternatives, and testing of the alternatives. The result is a new technique, design, or product which then needs to be disseminated. PLATO, the computer-assisted instructional system developed and tested at the University of Illinois, is one example of the rational change strategy at work (Havelock, 1973). Another example of model usage is the support of change in educational institutions by encouraging faculty members to formulate proposals based on the best evidence available. These proposals are then judged on the basis of rational considerations (Lindquist, 1978).

Lindquist (1978) found that the primary criticism of this model has focused on the isolation of research and development from its audience of users. Rational systems may be good ways to research and develop change,

but they don't explain the motivations and activities of those who will use or implement the change.

Human problem solving

The problem-solving theory addresses the processes of how people feel the need for change and then become willing to change (Lindquist, 1978). Emotions as well as rational reasons are basic factors in the model because it assumes that people are more likely to change when they feel that a personal need will be satisfied. The goal is to replace competition and a closed attitude with openness and collaboration (Baldridge, 1972). Once this is completed, the people in an organization can work together to solve its problems. The theory utilizes the changing attitudes and values of individuals and not the structure of organizations.

Initial processes of the model include a diagnosis of problems and the search for alternative solutions. This is similar to the initial steps of the rational planning model, but the emphasis is different. Solutions require improved communication, building trust, and improved individual and peer group relations (Baldridge, 1972). The applications and influence of humanistic and behavioral science to this theory are apparent. Users of this theory will often consult with faculty or departments in order to create awareness for the need to change. The assumption is that successful solutions require a feeling of ownership by those who must implement them (Nordvall, 1982).

Lindquist (1978) cited two main criticisms of the model as the

assumptions that (1) by changing individuals it is possible to change organizations, and (2) that conflict is the result of misunderstandings. Educational institutions prefer not to easily use this theory because it probes sources of resistance which have emotional rather than rational bases.

Social interaction

The major emphasis of this theory is the process by which change is communicated to and accepted by potential users (Lindquist, 1978). It explains how an innovation spreads. Specifically, it examines how diffusion takes place among individuals and, to a lesser extent, within organizations. Everett Rogers is most frequently associated with this school of thought and the agricultural research of Bohlen and Breathnach (1970) provided a typical representation of this approach. Rogers and Shoemaker (1971) found through a review of over 1500 articles that most empirical studies of innovation identified a few consistent types of potential adopters and a few stages in the adoption process. They were able to categorize adopters in any organization as innovators (4-7%), early adopters (12-15%), early majority (33%), late majority (33%), and laggards (15%). Their conclusions attempted to identify the characteristics of people in these categories, especially those most favorable to new ideas (innovators and early adopters), so that message of innovation could be targeted at these groups. Rogers and Shoemaker determined that once the adoption process begins, it follows a predictable pattern which is consistent enough to be mathematically

modeled. In the cycle of adoption, each successive adoption group requires increasing social persuasion in order to cause change.

Although it can take a short time for change to move from one adopter category to another, several years or decades is more common for new educational behaviors in a college environment (Lindquist, 1978). Social interaction diffusion researchers, according to Nordvall (1982), have found that once the innovation has been presented to the organization, the key to diffusion of the innovation is through opinion leaders, those people or groups to whom others turn for advice. Social interaction researchers have also concluded that certain aspects of innovations themselves, in addition to empirical reason, influence their adoption. Does the innovation have clear relative advantage for a particular situation? Is the innovation compatible with current values? Is the innovation divisible so that one can adopt only the parts they like? Is the innovation simple to understand? Can it be observed and tested on a trial basis? Social interaction research, according to Lindquist (1978), has created a new set of variables to be considered when working with the adoption and diffusion of innovation.

Criticisms of the social theory include the ignoring of the organizational aspects of change (Baldridge & Deal, 1975). Nordvall (1982) maintained that educational systems are not comparable to farms, and that educational systems are often not technical ones that can be easily evaluated. The theory stresses the adoption phase, but in education a major problems is the implementation of innovations after they have been adopted in principle (Paul, 1977). The model also

emphasizes the value of opinion leaders, but studies have been unable to determine a particular set of characteristics of opinion leaders, as would be predicted from literature on the diffusion of innovations (Baldridge & Deal, 1975).

Political

In the political theory, faculty departments, for example, feel and articulate the need to change. They are willing to implement the change, but must first influence the administrators who have the authority to make the changes. Similarly, there have been times when faculty desired to make curriculum changes but had to first convince their chairperson or dean to implement the change. This theory focuses on political power and its processes as prerequisites to achieving change. The ultimate goal of change is sometimes to rearrange the power structure within an institution rather than modify the attitudes of persons currently in power.

The political process of change begins with a person or group who wants to cause a change. There is no phase of the theory designed to formally diagnose the problem or to generate solutions. Instead, the question asked by those who seek a change is simply how to get it. Those seeking the change need to build coalitions among influential persons and/or opinion leaders (Lindquist, 1978). Power is used to convince the authorities to institute a change. In the political theory, authorities are generally viewed as people to be influenced (Nordvall, 1982). However, Conrad in 1978 did an analysis of curricular change at four

institutions. He found that administrators were not merely a passive group reacting to pressure but were actually a vested interest group who intervened in the process as either facilitators or resisters, and who influenced the policy recommendations growing out of the policy change.

In educational institutions, academic change proposals can be adopted as policy quickly if a president exercises his formal authority (Lindquist, 1978). However, the unresolved procedures to be used for implementation of innovation within the political theory have generated its greatest amount of criticism. If vested interests and power were the only considerations of planned change, a change agent would only have to produce an effective political strategy. The previously discussed change theories have indicated that many other variables (i.e., individual, technical and organizational) must be considered. Often, according to Lindquist, it is more effective to reduce resistance to change by human relations strategies than by administrative force. In addition, Baldridge and Deal (1975) made the point that the political theory fails to account for instructional policy generation because instructional change is often an operational decision made by an instructor or administrator.

Linkage

The linkage theory is a synthesis of the above four theories and was primarily developed by Havelock in 1973. It has a dual focus: the internal problem-solving process of the user, and the linkage of this process to external resources. Persons interested in educational change

need to be linked to sources external to the educational institution through which innovations may be diffused. These people should also be linked to opinion leaders or other diffusion channels within the institution. Both the structure of the organization and the attitudes of its internal members may need to be altered for change to occur. Since this theory is a combination of the other theories, it shares their orientations. Nordvall (1982) summed up the process as follows: Rational planning is employed in developing new ideas. Ideas are exchanged through social networks. Human barriers to change must be confronted and overcome by solving problems. Finally, power and authority often need to be confronted and plans for change must flow through the institution's authority system.

Havelock (1973) identified seven factors present in successful change efforts from his review of the literature: (1) Faculty, administrators and all interested parties should be well-linked to each other and to the information concerning problems and solutions. (2) There should be an active openness to new information and new people across departmental and institutional boundaries. (3) Change efforts should be organized with follow-through procedures. (4) The processes should be supported by capable leadership, adequate time, and materials. (5) Useful information and pertinent resources should be coordinated together. (6) Change efforts at all stages should be rewarded. (7) Change attempts should be numerous, various, and redundant. These factors represent procedures to be followed for the successful implementation of change.

The linkage theory, according to Nordvall (1982), is considered more comprehensive than the other models discussed above but is often criticized for being too abstract. It is often accompanied by a diagram of the user's internal problem cycle, another diagram representing the steps of solution, and arrows showing the linkage between the two diagrams. This illustration does not make clear which practices, internal to the problem-solving process or external in the linkage process, should be changed in order to implement the theory. It is also not clear how the theory can be adapted to a setting within an institution of higher education (Lindquist, 1978).

Summary: Part II

The five theories of change (research, development and diffusion; human problem solving; social interaction; political; and linkage) discussed in this section are those most frequently mentioned according to the literature reviewed. They themselves are based on literature reviews and are supported by a variety of research studies. Each theory has sought to answer the question: what brings about changes in attitudes and behavior? Some people believe that humans are essentially rational beings. Others find that humans are social creatures. Still others feel that psychological barriers are the primary obstacles to change. Yet, other groups maintain that humans are politically oriented and very concerned with protecting and strengthening their vested interests. Havelock's linkage theory assumed that all of the above four factors were important and, therefore, attempted to combine their change

assumptions into a separate theory. These theories of change help explain and identify the variables and processes associated with change. These theories have contributed to the understanding of the processes of change within institutions of higher learning.

Theories of the change process draw from both research about change and research about the diffusion of innovation. Consequently, knowledge of the theories of change can aid in the description and analysis of the interrelationships between the variables which influence the adoption and diffusion of computers for instructional purposes in higher education.

Part III: Theories of Change Relevant to Education

Various theories describe or recommend processes for change in individuals or organizations. These theories serve to provide concepts about the change process and a background necessary for developing change strategies. As noted in Part II, there are several theories which provided different explanations of how change occurs. The theories discussed were general in nature and limited to single sets of variables. Although the linkage theory attempted to integrate the concepts of the other four theories, it has been criticized for lack of specificity. This section will describe theories intended to conceptualize the educational change process. These theories are categorized into environmental (external to the institution), organizational (internal to the institution), and instructional content. The instructional content theory is specific in nature and relates to provoking educational change

within existing academic structures.

Environmental models

In 1973, Levine theorized that educational reform was a reflection of changes in organized society. He argued that educational change cannot move ahead of society and that changes in society will dictate or cause educational changes. His theory described a situation where society directly influenced (1) educational goals and budgets, (2) the selection of nonfinancial resources and personnel, (3) educational processes whereby resources are mobilized and coordinated to achieve goals, and (4) educational outcomes. The political and economic outcomes of educational change in turn reinforced the society which had initiated the change.

The Levine theory has several implications for those who aspire to create educational change (Zaltman et al., 1977). First, attempted change should be developed and presented in a manner consistent with the goals and values of society. Second, major educational changes should be introduced when major changes are occurring in society in order to avoid retardation of the change by society. Third, an educational change agent should identify and utilize sources of influence from society which are most important to the change effort. In short, a move to change or innovate within education must reflect a need within society.

Stiles and Robinson (1973) reviewed literature on theories of change and developed a political process theory for educational change that reflected the mode of external (i.e., environmental) forces on internal

change. This theory has five basic steps to be followed in the order presented. They are: (1) development: organizing the people which have unmet needs and articulating proposals or complains; (2) diffusion: dissemination of requests or demands through public protest and criticism; (3) legitimation: gaining recognition of the need for change among policy makers and resource allocators; (4) adoption: acceptance by educators of their responsibility to utilize the innovation; and (5) adaptation: actual implementation of change with or without modification. Zaltman et al. (1977) cited the value of this theory as one which explained the influence of external forces on educational change. Although educators may be placed in a reactive position late in the process, they may be forced into change through legislative mandates.

Another major implication of the political process model for the educational change agent is the importance of connecting a desired change with an unmet need of interest groups. Creative use of interest groups can enhance the development, diffusion, and legitimation phases. The educational change agent can also play an important role in each phase as a disseminator of appropriate information.

Internal models

The Zaltman, Duncan, and Holbek theory (1973) considered the effects of the internal environment of an organization on the change process. This theory, according to Zaltman and Duncan (1977) contained two basic stages: initiation and implementation. The initiation stage was composed of (1) knowledge or awareness, (2) attitude formation, and (3)

decision formation. It consisted of obtaining and processing information sources, and effective channels of communication were considered essential. The second or implementation stage was partitioned into two phases: initial and sustained. The implementation stage began with trial usage of the innovation and, if successful, became a sustained activity.

Five organizational characteristics may affect the two stages: complexity, formalization, centralization, interpersonal relations, and conflict resolution (Zaltman et al., 1977). The term "complexity" referred to the number of different occupational specialties within the organization. A school was considered complex because of the high number of teachers isolated in relatively autonomous classrooms and the diversity of individual differences with which they functioned. Teachers work with a certain degree of independence and have opportunity to discover areas in need on innovation. However, because of adversity in perspectives among faculty members, arriving at common decisions of how to innovate was considered to be difficult. Thus, an unspecified amount of complexity facilitated initiation of an innovation but interfered with its implementation. The term "formalization" referred to the degree of emphasis that an institution placed on following specific guidelines, rules, and procedures in the execution of job functions. Zaltman's literature review led him to the conclusion that schools are highly formal, a characteristic that made initiation of innovations difficult.

The term "centralization" referred to the location of the decision-making power within an organization. A highly centralized institution

was one in which authority and decision-making were concentrated heavily at the top of the organization. Schools tended to be highly centralized, a characteristic which facilitated awareness of innovation but did less to aid the initiation or implementation of change programs (Zaltman et al., 1977). Close interpersonal relations among organizational members facilitated both stages of the innovation process. Communication among educational personnel was often sporadic and superficial, a situation which had implications for educational change agents. Finally, the ability to deal with conflict may influence the innovation process. Conflict arises during both stages, initiation and implementation, of the change process. Recognition of the existence of conflict and an open discussion of disputed issues was recommended to facilitate the innovation process.

An important implication of the Zaltman, Duncan, and Holbek model is that institutional characteristics which facilitated the introduction of innovations may make implementation difficult, and conversely, characteristics favoring easy implementation may make initiation difficult. The educational change agent may need to develop special organizational designs to facilitate this dilemma. For example, when an educational institution is highly centralized, the initiation of change is more difficult than its implementation (Zaltman et al., 1977). To resolve this situation, some schools have created special change teams at the teacher level in order to identify, evaluate, and make recommendations about the adoption of innovations. The theory also implied a significant distinction between initiation and implementation

because many changes are initiated but not implemented. The existence of follow-up mechanisms was considered very essential. One follow-through approach that has experienced success is one that required the users of an innovation to periodically report on its degree of success.

The initiation stage of this model provided a theoretical basis in this study for evaluating the information sources of an innovation. The initiation stage also provided a basis for evaluating the relationships which may exist between educators and institutional variables regarding the adoption of computers for instructional purposes.

Instructional content models

In 1971, the Educators' Communication Committee of the Interuniversity Communications Council (EDUCOM) initiated a study funded by the National Science Foundation to determine why instructional computing was not making significant progress in education. EDUCOM believed that this lack of progress was in spite of the fact that the National Science Foundation and the U.S. Office of Education had spent over 150 million dollars in support of instructional computing over the previous ten years. According to the study, the most substantial obstacle to widespread use of computers in instruction was the lack of quality and readily available computer-based materials. The next most significant obstacles were the lack of professional and economic incentives for developing materials, and the lack of incentives for faculty to devote time and efforts towards the creation of instructional materials for others. One of the results of this study was a small scale

model for producing and distributing inexpensive instructional material within the framework of existing academic structures.

The theory proposed six factors essential to the development of instructional computing. These factors were (1) convincing high-quality demonstration, (2) observable effectiveness, (3) evidence of value and production distribution mechanisms, (4) professional recognition with economic incentives, (5) quality documentation by good authors, and (6) quality computer-based materials. The model emphasized the traditional teaching resource, a book, rather than computer programs because the EDUCOM study had reported that change had to take place within existing academic structures. The model was tested over a period of five years where educators, who had made computer instructional proposals, spent two successive months at Dartmouth College in order to develop their projects within the model's structure. As a result, 25 textbooks and over 5000 pages of instruction material were developed.

The theory represented an approach to educational change through existing educational structures and traditional methods of instruction. Its success depended on the individual teacher and his role in selecting appropriate instructional materials for his own courses. It acknowledged the fact, as reported in the EDUCOM study, that a significant number of courses undergo change as a result of a teacher deciding to use a new text instead of the old one. Morton and members of the EDUCOM study group had reasoned that if teachers could easily obtain from a textbook salesman various examples of good computer-based instructional material, the chances of adoption and change would be higher than if an independent

organization tried to market material on its own.

This research and model represented an approach to educational change which focused on change through the use of an existing medium, the book form, and within the existing curricula. The implications of this study for the author's research were that the lack of quality computer-based software or demonstrated instructional effectiveness through the use of a computer may still be variables which influence the adoption of computers. Questions relating to these concerns were included in the survey questionnaire of the author's study.

Summary: Part III

As noted in Part II, there are a number of different perspectives from which planners and managers of change view individuals and organizations. The theories and models discussed in Part III, which have been considered more appropriate for educational applications, emphasized multiple components and purpose. The diversity of education in function, structure, and governance requires the usage of theories and models of change which integrate external, internal, individual, and content specific components. The theories or models presented here add another dimension or level of complexity to the educational change process. In addition, the theories of change relevant to education discussed in this section have both influenced and added credibility to the selection of variables on the adoption and diffusion of technological innovation which were used in the author's study. These variables were (1) the effect of informational sources on change, (2) the demonstration of effectiveness

of an innovation prior to change, and (3) the need for quality computer-based software prior to change.

Part IV: Conclusion

The processes of change in educational institutions are controversial and complex. The literature reviewed for this study indicated that there was no single established theory to explain how change occurs in higher education. Also, there was no single answer to the question of why innovation fails. Resistance barriers or inhibitors to change occur external to an educational institution, within an educational organization, within individual members of an organization, and are related to the innovation itself. The theories of change which are not a synthesis of other theories tend to concentrate on only one aspect of the change process. The theories which do synthesize multiple dimensions of the change process tend to be abstract and less tangible. An educational change agent cannot look only to a single theory of change or to a single set of facilitators or inhibitors when trying to instigate change. Given the variety of types of educational institutions and the large variety of resistance to change variables, it does not appear likely that there are single theories or simple solutions to facilitate the change process. The literature about change does, however, provide some very broad guidelines on which there is strong agreement.

CHAPTER III. METHODOLOGY

This chapter on research procedures contains a description of the sources of information used for data collection, a description of the sample, and a description of the procedures and steps taken to complete the study.

Sources of Information for Data Collection

The data for this research were obtained from a survey questionnaire of all the faculty at a large metropolitan community college district. The district was composed of seven colleges with both urban and suburban locations. A total of over 50,000 full-time students attended these colleges. The survey instrument (see Appendices A and B) was designed by the investigator to collect information relating to faculty computer practices and perceptions about the use of a computer for instructional purposes. The questionnaire was divided into four main sections: (1) faculty personal data; (2) faculty sources of information about computers; (3) faculty computer usage practices; and (4) faculty perceptions of possible barriers to their adoption of a computer for instructional purposes.

The personal data section included the college at which they were employed, their age and sex. These independent variables were selected in order to provide additional information about existing relationships, and a knowledge of their frequency distributions was pertinent to the statistical assumptions of the study. The sources of information section requested information about eight likely ways in which information about

computers could be obtained and the date when the information was first obtained. The section on actual computer usage or practices requested information from fourteen questions designed to identify the extent to which the faculty used a computer. Each question also requested the date of the first occurrence of the practice. The length of time that the faculty had been using a computer ranged from zero to 16 years. The extent to which the sources of information were used and the extent to which the computer practices were engaged in were termed the "intensity" of adoption for the purposes of this study. The section of faculty perceptions was designed to request information about what the faculty believed to be true in four main areas: the technical nature of the computer itself; faculty personal biases about the use of a computer; the economic climate of their college; and the attitudes of their college administrators towards the use of educational computing. Possible responses to the perception questions ranged from strongly agree to strongly disagree in five separate categories.

A panel of six experts in the field of community college education reviewed three drafts of a pilot questionnaire for clarity, readability and face validity of the questionnaire items. After the third time, the panel had no further recommendations. The selection of these people was based on their areas of academic expertise. Two of the members were administrators, and the remaining four were full-time faculty members. All six members were employed by the district which was surveyed in this study. Three of the panel members held Ph.D. degrees, and the remaining three held master's degrees in their fields of teaching. One of the

administrators was responsible for district institutional research, and the other administrator regularly taught seminars to faculty on various topics relating to the completion of their Ph.D. dissertations. One of the faculty member's specialty was the field of written composition, two of the faculty were computer science teachers, and one was a mathematics teacher who was interested in computer-assisted instruction. Statistical reliability tests were not performed on the pilot instrument used in this study. However, feedback from the six experts indicated no confusion about the survey items. They felt that they knew what the questions were asking and that they were clearly stated.

The survey was conducted in the Fall of 1983, and care was taken to distribute the questionnaire at a time during the semester when no atypical activities were occurring. Each questionnaire was printed on yellow paper and sequentially coded with numbers. The purpose of the color was to draw faculty members' attention to it. The coding scheme protected confidentiality of respondents (no names were requested) and avoided possibilities of respondents returning multiple copies. All of the surveys were distributed and returned through the internal mail system of the district. Follow-up reminders (see Appendix C) were sent to all faculty twice, one week apart, in order to obtain a sample response which could be considered statistically representative of the general population. Return addresses were printed in advance and provided with each questionnaire and follow-up reminder.

Description of the Sample

The research sample used in this study was drawn from all of the full-time faculty members of a large metropolitan community college district. The faculty members were distributed among the seven colleges of the district, and a total of 535 questionnaires were mailed. Although there was a total of 563 full-time faculty members within the district, it was determined that 28 members were unavailable at the time of the mailing. Ten faculty members were not currently listed on the payroll for a variety of reasons, six members were on sabbatical leave, and 12 members were interning in nonfaculty positions. A total of 305 faculty members responded to the questionnaire, which represented 57% of the total available faculty population. Fifty-six percent of the respondents were male, and the average age was 42 with a range between 22 and 63 years. The percentage of respondents by college was closely related to the percent of faculty per college within the district. Chapter IV discusses the results and basic frequency statistics in detail.

All colleges were advertised by the district as comprehensive community colleges. Although they varied in size and personnel, all of the colleges had identical administrative organizational structures. The college curriculums varied between colleges, but the same 60 subjects were taught by five or more of the colleges. Thirty of these subjects were taught at all seven of the colleges. All of the colleges used the same centralized computing facilities of the district for their instructional and administrative applications. The number of

microcomputers available for faculty at each college and their degree of availability could not be determined in a reliable fashion.

Description of the Research Procedures

The type of research design used was a descriptive survey study. The general goal was to identify the relationships between selected variables which influence the adoption of educational innovation among community college faculty. In this case, the innovation was considered to be the use of computers for instructional purposes, and the adopters were a selected sample of community college faculty.

The selection of variables to study were guided by a review of the literature pertinent to the adoption of technical innovation (see Chapter II). The research of Rogers and Shoemaker (1971), Bohlen and Breathnach (1970), and others determined that the adoption of innovation was related to the sources of information about an innovation. Katz et al. (1980) concluded from a review of the literature that organizational variables are related to the adoption of innovation. Levine (1980) concluded that individual variables contribute to the resistance of innovation. In 1982, Rose classified the barriers to the adoption of technical innovation in education into four categories as perceived by the faculty. These categories were educator, administrative, economic, and the innovation itself. The selected variables in this study included a combination of individual and organizational variables as they related to the adoption of computers for instructional purposes. Eighteen survey questions about perceived potential barriers to the adoption of computers

for instructional purposes were designed to address the classification structure of Rose.

The steps taken to collect the data were as follows: (1) The questionnaires were mailed to the faculty at an appropriate time during the semester in order to maximize responses. The date selected for the initial mailing was October 15. (2) A reminder to complete and return the questionnaire was mailed one week later. (3) A second reminder was mailed after one more week.

Once the questionnaires were collected, the data were coded for computerized statistical analysis and basic frequencies were calculated for all variables. The frequency data were used to verify data integrity and to provide a basis of data validity for further statistical analysis. A variety of statistical tests were then calculated to test the hypotheses, and the results are described in Chapter IV. The analysis statistics used were: (1) frequencies and means; (2) factor analysis using Varimax rotation; (3) reliability coefficients for all factors; (4) Pearson correlation coefficients; (5) one-way analysis of variance with the Duncan and Scheffé test; and (5) multiple regression.

Hypotheses Testing Procedures

A review of the study objectives will assist the reader to understand the procedures which were undertaken. These objectives were:

1. To describe faculty computer usage practices and the degree of adoption of these practices.
2. To describe the factors that were perceived to either facilitate or

serve as barriers to the adoption and diffusion of computers for instructional purposes.

3. To examine the interrelationships among the factors that effect the adoption and diffusion of computers for instructional purposes.
4. To examine the relationships between perceived factors and faculty computer practices.
5. To describe the areas of faculty intensity of adoption from the self-reported computer usage practices.

The hypotheses were tested through the following steps and procedures. (1) The initial step required the identification of groups or categories of adoption practices and faculty perceptions. This was accomplished through the use of factor analysis. Identified factors were then tested empirically to determine their reliability coefficients. Factors which did not have moderate to high reliability were discarded from the study. (2) The next step required the identification of logical groups or clusters of the adoption practices and perception data. The objective was to determine which of the survey questions could be grouped logically and in a meaningful manner for the study. Identified clusters were tested empirically for reliability and clusters which did not have moderate to high reliability were also discarded from the study. (3) This step involved the combining of similar factors and clusters and the elimination of duplicate or non-germane groups. This was completed by analyzing the data from both empirical and logical points of view. Care was taken not to reduce the statistical reliability of any of the selected factors or clusters. The end result of this step was a small

group of clusters and factors which were statistically reliable and pertinent to the hypotheses being tested. Four of these groups related to faculty perceptions, and the remaining ones identified adoption practices. (4) The fourth step required the calculation of intercorrelations between all factors and clusters. (5) Finally, the independent variables of age, sex (gender), and college were compared to each factor using a one-way analysis of variance test. The hypotheses and comparison tests are listed as follows.

Hypothesis number 1 There is no significant relationship between perceived institutional economic barriers and faculty adoption. The perceived institutional economic barrier cluster was compared to all of the adoption areas.

Hypothesis number 2 There is no significant relationship between perceived technical barriers and faculty adoption. The perceived technical barrier cluster was compared to all of the adoption areas.

Hypothesis number 3 There is no significant relationship between perceived administrative barriers and faculty adoption. The perceived administrative barrier cluster was compared to all of the adoption areas.

Hypothesis number 4 There is no significant relationship between perceived educator barriers and faculty adoption. The perceived educator barrier cluster was compared to all of the adoption areas.

Hypothesis number 5 There is no significant relationship between

sex and all measures of faculty adoption or educational perceived barriers. The sex (gender) of the respondents was compared to all of the adoption areas and perceived barriers.

Hypothesis number 6 There is no significant relationship between age and all measures of faculty adoption or educational perceived barriers. The age of the respondents was compared to all of the adoption areas and perceived barriers.

Prediction of Factors

The final step of the data analysis was designed to determine if factors or variables could be predicted from selected and related combinations of factors and variables. This process was achieved through the use of multiple regression techniques, and the results are reported in Chapter IV. Although the identification of prediction factors or variables was not germane to hypotheses testing, it was considered relevant information to the stated objectives of the study.

CHAPTER IV. RESEARCH FINDINGS

This study was conducted to investigate the relationships between selected variables and the adoption of computers for instructional purposes. The data collected were subjected to both statistical and subjective analyses. The results of these procedures and analyses are described in this chapter. Specifically, information is included on the sample distribution, item frequencies, factor analysis, reliability, correlation, analysis of variance and multiple regression. Discussions and statistical tables of these topics are included with a presentation of findings. Finally, the results of the hypotheses tests are summarized.

A return of only 57 percent of the surveys was disappointing but could probably be attributed to the large size of the questionnaire, which took more than 15 minutes to complete. An initial review of the surveys indicated that one of the variables would not be usable because it was often misinterpreted by the faculty. This question requested respondents to indicate the subject area in which they taught. Many of the faculty mistakenly listed the college division in which they taught instead of their subject area. This variable was discarded from the study. The survey concluded by requesting answers to three open-ended questions which specifically asked the faculty for the main reasons that they didn't use a computer more for instructional purposes. A large portion of the respondents did not complete these questions, and a majority of those who did said that they lacked the time to learn about or use computers. These questions were also discarded from the study.

Sample Distribution

The procedures used on this study were applied to a population of 305 community college faculty members. Tables 1 through 3 represent the frequency distributions for the faculty surveyed in terms of their sex, age, and the college at which they were employed within the community college district. Table 1 illustrates the ratio of males and females who responded to the questionnaire. Examination of these data demonstrated that the ratio of respondents by sex (gender) to the total number of faculty in the district was quite similar. Thirteen percent more males responded to the survey than did females.

Table 1. Sample frequencies of faculty by sex (gender)

Sex	Sample		Population	
	Frequency	Percent	Frequency	Percent
Male	171	56.4	290	54.2
Female	132	43.6	245	45.8
Missing	2			
Total	305	100.0	535	100.0

Table 2 illustrates the distribution of ages among the respondents and is categorized into four groups. These groups approximated plus and minus one and two standard deviations from the mean. The table provides summary statistics about the distribution and the data indicate a normal distribution by age for the purposes of statistical analysis.

Table 2. Sample frequencies of faculty by age

Age	Frequency	Percent	Distribution
22-33	45	11.2	Mean = 42.2
34-41	126	41.3	Std Dev = 7.5
42-49	91	29.8	Max = 63
50-63	54	17.7	Min = 22
Total	305	100	Range = 41
			Mode = 41
			Median = 41

Table 3 illustrates the frequency distribution of survey respondents according to the college at which they were employed. The number of respondents by college was closely proportionate to the number of total full-time faculty members employed by each college. At least 30 faculty at each college responded to the survey. Tables 1 through 3 demonstrate a sample distribution of faculty by age, sex (gender) and location of employment within their district. This sample is a representative data base from which inferential statistics can be calculated and conclusions drawn.

Item Frequencies

Faculty computer practices were separated into two components in the survey instrument. One component consisted of the sources of faculty computer information (Appendix A, Part II, Section A), and the second recorded the faculty computer usage activities (Appendix A, Part II, Section B). The data in Tables 4 and 5 demonstrate the mean responses for these questions. The number of times that the faculty had used the

Table 3. Sample frequencies of faculty by college

College	Sample		Population	
	Frequency	Percent	Frequency	Percent
1	30	9.9	51	9.9
2	31	10.1	36	6.8
3	39	12.7	87	16.2
4	82	26.9	139	26.0
5	36	11.7	59	11.0
6	28	9.1	47	8.8
7	60	19.6	116	21.7
Total	305	100.0	535	100.0

information sources or had engaged in the practices is listed in one column. The date of first occurrence in which the faculty began a practice was subtracted from the current year. This difference is listed in another column in both of these tables as the number of years since the practice first began. The data included a large number of non-adopters for each question and are summarized as the percent of non-adopters. At least 29 percent of the faculty indicated no adoption to every question about computer practices. However, this did not mean that 29 percent of the faculty had never engaged in a particular computer practice. It reflected the fact that not every faculty member had participated in every practice.

Table 4 illustrates where the faculty found information about computers, the number of times they used the information sources, and number of years since they first used the sources. The data identified computer books and manuals as the primary source of information as well

as the most frequent initial source of information about computers. Table 5 illustrates the types of computer usage practices, the number of times that the faculty engaged in those practices, and the number of years since they first engaged in the practices. The data in Table 5 identified the primary uses of computers as programming, and data manipulation of various sorts (questions 10 and 19). The data also demonstrated that the faculty spent an average of 68 minutes per week reading or learning about computers, and eight hours per month actually using a computer. If the number of years since first occurrence is interpreted as the number of years of usage, then all the data in these two tables can be interpreted as indicators of the intensity of computer adoption.

The final part of the questionnaire (Appendix A, Part III) collected data about faculty personal beliefs or perceptions regarding the adoption of computers. The eighteen questions were designed to ascertain

Table 4. Mean responses to sources of computer information

Question number	Description	Number of times used	Number of years used	Percent non-adopters
1	Journals subscribed to	2.38	1.52	70.2
2	Books or manuals	7.39	3.36	40.0
3	Formal college classes	1.45	2.96	62.0
4	College seminars	2.45	2.19	30.4
5	Commercial seminars	1.09	1.55	73.4
6	Vendor or sales sessions	1.33	1.39	70.2
7	User groups	0.39	0.87	83.2
8	Professional meetings	2.95	2.14	46.2
Mean		2.43	2.01	59.4

Table 5. Mean responses to computer usage practices

Question number	Description	Number of times used	Number of years used	Percent non-adopters
9	Home computer owner	0.37	0.69	70.2
10	Written any programs	11.30	2.89	60.3
11	Written educ. programs	5.04	1.58	74.7
12	Modified educ. programs	3.88	1.38	77.7
13	Purchased any software	3.53	0.94	68.8
14	State or national meetings	1.44	1.08	81.3
15	Committee member	1.08	1.10	76.1
16	Searched educ. software	4.11	1.41	56.7
17	Classroom demonstrations	5.61	1.39	70.2
18	Educ. management use	4.69	1.02	73.1
19	Tool--any purpose	16.91	2.50	49.8
20	Student assignments	9.93	1.48	72.8
21	Computer purchase requests	1.63	1.16	67.9
22	Software purchase requests	1.72	0.89	68.2
23	Reading (min./week)	68.50	--	29.2
24	Usage (hours/month)	8.45	--	37.4
Mean		5.10	1.40	69.0

information about possible barriers to the use of computers for instructional purposes in four areas. These perception categories were the administrative attitude of their college towards educational computing, the economic climate of their college, faculty personal biases about the use of a computer for educational purposes, and the technical nature of the computer itself. A review of the perception item responses demonstrated that some items invoked stronger responses than others. These differences are highlighted in Table 6 by summarizing the five Likert scale categories as percentages.

Table 6. Response percentages of faculty perceptions

Question number	Description	Non-barrier			Barrier	
		Percent strongly agree	Percent agree	Percent uncertain	Percent disagree	Percent strongly disagree
1	Important to use computers	31.0	40.0	19.7	6.0	3.0
2	College lacks money for purchase	12.8	35.0	24.3	19.0	8.5
3	Money for computing is not allocated	21.6	38.7	26.9	9.8	3.0
4	Lack of long-term funding	14.4	50.8	30.5	3.0	1.3
5	Computers have many advantages	22.3	53.4	18.4	3.0	3.0
6	Computers will not improve quality of education	21.3	46.2	21.6	7.5	3.0
7	Computers are difficult to operate	18.7	59.0	10.5	10.2	1.6
8	A computer is rarely available for use	4.3	40.3	19.0	28.2	7.9
9	Easy to understand the value of computers	25.6	56.1	11.8	4.3	2.3
10	Administration rewards computer users	4.9	33.8	51.1	8.9	1.3
11	Administration encourages computer use	5.9	51.1	23.9	17.0	1.6
12	More plans for computer use are needed	8.9	41.6	9.8	31.5	8.2
13	Interested in using computers more	27.5	43.9	17.0	8.9	2.6
14	More technical assistance is needed	4.6	10.8	7.2	53.8	23.0
15	Computers will replace teachers	39.7	47.9	8.5	2.3	1.6
16	Current teaching method is fine	18.6	52.5	16.7	8.2	3.3
17	Lack of time for computers	6.9	44.3	18.0	2.3	7.2
18	Decision to use computers depends on others	3.9	26.2	18.7	38.0	12.1
Mean		16.3	43.2	19.8	15.7	5.1

In addition, the questions were statistically analyzed so that a response of agreement (strongly agree or agree) implied a non-barrier situation and a response of disagreement (strongly disagree or disagree) implied a barrier situation. The percentages in the table reflect this analysis. A barrier was defined as a hindrance to the use of computers for instructional purposes. For example, at least 60 percent of the faculty responses for questions 1, 3, 4, 5, 6, 7, 9, 13, 15 and 16 did not indicate the existence of a barrier condition. Approximately 76 percent of the faculty responses for question 14 indicated the existence of a condition of hindrance toward the use of a computer for instructional purposes. A meaningful analysis of these data, and the data in Tables 1 through 5, required the use of additional statistical tools in order to identify relationships among variables and groups of variables.

Factor Analysis, Reliability, and Correlation

Individual faculty practice and perception items were analyzed empirically for factors using varimax rotation. The purpose for this procedure was to determine the number of constructs that underlie the survey variables. Thirteen factors were discovered empirically through factor analysis and are illustrated in Table 7. In addition, 10 logical data clusters were identified subjectively by the author and are defined in Table 8.

Reliability coefficients for the 13 factors and 10 logical clusters were derived from the use of Cronbach's alpha test. The results of these tests are also illustrated in Tables 7 and 8. Factor reliability

criteria were based on the value of alpha. A value of 0.60 or above indicated high reliability, values between 0.50 and 0.59 indicated moderate reliability, and figures below 0.50 indicated questionable or poor reliability. Factors and clusters with poor reliability were discarded from further analysis. Consequently, factor number 2 (Table 7), which had an alpha of only 0.35, was discarded from further consideration. All the remaining factors and clusters had high reliability coefficients.

Table 7. Factor analysis and reliability test results

Factors	Questions loading	Eigen-value	Cum percent	Reliability		
				Alpha	Mean	Std. dev.
	Information sources					
1	(N) 2 3 4 5 6 8	4.09	51.1	0.73	15.30	34.93
2	(N) 1 3 7	0.73	60.2	0.35	2.79	12.79
3	(Y) 1 3 4 6 7 8	4.69	58.6	0.85	11.20	17.87
	Usage					
4	(N) 10 11 12 17 20	6.38	39.9	0.86	1.45	1.81
5	(N) 15 16 21 22	0.84	45.1	0.79	1.31	1.47
6	(N) 9 13	0.58	48.7	0.70	0.61	0.81
7	(Y) 13 14 15 16 21 22	6.61	47.2	0.87	6.51	12.48
8	(Y) 10 11 12 15 17 20	0.89	53.5	0.88	8.77	16.54
9	(Y) 10	0.54	57.4			
	Perceptions					
10	9 16	3.54	19.7	0.72	12.80	4.23
11	2 3 4	2.59	34.0	0.72	5.02	1.62
12	10 11	0.94	30.3	0.63	5.24	1.42
13	12	0.69	43.1			

N = Number
Y = Years

Table 8. Logical clusters and reliability test results

Logical clusters	Questions	Reliability		
		Alpha	Mean	Std. Dev.
	Information Sources			
1	(N) 1 2 3 4 5 6 7 8	0.78	19.74	46.78
2	(Y) 1 2 3 4 5 6 7 8	0.91	15.97	25.78
	Usage			
3	(N) 9 through 22	0.90	4.34	4.21
4	(Y) 9 through 22	0.91	19.53	31.47
5	(N) 23 24	--	--	--
6	(N) count (9 - 22)	0.87	4.33	4.19
	Perceptions			
7	10 11	0.63	5.24	1.42
8	1 13 16 17	0.71	9.24	2.91
9	5 6 9	0.76	6.32	2.19
10	2 3 4	0.72	5.24	1.42

N = Number
Y = Years

The factor analysis and reliability calculations resulted in 12 factors which were determined through empirical measures to have similar constructs and high reliability. Ten logically formed clusters were assumed to have similar constructs and were found empirically to also have high reliability coefficients. A reduction of factors and clusters to those pertinent to the study was next completed. Since clusters 1 and 2 measured the same variables as factors 1, 2, and 3, it was decided to eliminate the three factors from further analysis. Factors 6, 7, 8, 9, 10, and 13 were not pertinent to the study by themselves and were

discarded from further analysis. Logical clusters 7 and 10 were also eliminated from further analysis because they were identical to factors 11 and 12. The remaining factors and clusters were all considered for further analysis. These factors and clusters represented areas of faculty computer adoption and groups of faculty perception categories. This information is summarized in Table 9.

Table 9. Pertinent areas of faculty adoption and perception barriers

Factors	Description	Area
4	Used computers, written programs	Adoption
5	Served on committees, made formal requests	Adoption
11	Economic perceptions	Perception
12	Administrative perceptions	Perception
Clusters	**Description**	**Area**
1	Intensity of information source usage	Adoption
2	Mean time of information source usage	Adoption
3	Intensity of usage practices engaged in	Adoption
4	Mean time of computer practice usage	Adoption
5	Time spent learning about and using computers	Adoption
6	Number of different usage practices engaged in	Adoption
8	Personal biases about educational computer usage	Perception
9	Perceptions about computers themselves	Perception

There are eight factors and clusters listed in Table 9 which represent different measures of the intensity of adoption. Factor four represents the sum of five computer usage practices (questions 10, 11, 12, 17, and 20), and its intercorrelation coefficients ranged between

0.57 and 0.75. Factor five represents the sum of four computer usage practices (questions 15, 16, 21, and 22), and its intercorrelation coefficients ranged between 0.51 and 0.76. Cluster one represents the sum of all eight information sources (questions 1-8). Cluster two represents the average length of time of usage of all information sources (questions 1-8). Cluster three represents the sum of computer usage practices from questions 9-22. Cluster four represents the average length of time of computer usage practices from questions 9-22. Cluster five represents the average time spent learning about and using a computer from questions 23 and 24. Cluster six is a count of the number of practices the faculty engaged in from questions 9-22.

In summary, the eight areas of adoption (factors 4 and 5, and clusters 1-6) represent different measures of the intensity of adoption. Clusters one and three measure the amount of computer usage. Clusters two and four represent measures of the length of time of computer usage. Cluster five represents a measure of the time spent learning about and actually using a computer. Cluster six represents a measure of the number of different types of usage practices in which the faculty had participated. Factors four and five also measured the amount of computer usage but only from selected computer practices. Table 10 provides a profile summary of the eight areas of adoption.

There are four factors and clusters listed in Table 9 which represent potential educator perception barriers. Factor 11 represents the sum of three perceptions (questions 2, 3, and 4), and its intercorrelation coefficients ranged between 0.58 and 0.72. Factor 12

Table 10. Profile of adoption areas

	Adoption area description	Mean amount used	Number of questions
Factor			
4	Selected computer practice usage	3.4	5
5	Selected computer practice usage	1.7	4
Cluster			
1	All information source usage	2.4	8
2	Information source usage (years)	2.4	8
3	All computer practice usage	3.7	14
4	Computer practice usage (years)	1.9	14
5	Learning or using (hrs/month)	9.55	
6	Number of practices used	4.3	14

represents the sum of two perceptions (questions 10 and 11), and its intercorrelation coefficient was 0.78. Cluster eight represents a composite of perception questions 1, 13, 16, and 17. Cluster nine represents the sum of perception questions 5, 6, and 9. Thus, the four perception categories represented unique measures of potential barriers to the adoption of computers for instructional use.

The factors and clusters shown in Table 9 were subjected to Pearson correlation analysis to determine the degree of inter-factor/cluster relationships. The correlation coefficients resulting from this procedure are listed in Table 11. An examination of these correlations demonstrated a high correlation (0.6 and above) between several of the factors and clusters. The factors and clusters with high inter-correlation values are marked with asterisks. The data in Table 11

Table 11. Inter-factor/cluster correlation values

	Factors				Clusters							
	4	5	11	12	1	2	3	4	5	6	8	9
Factors												
4	1.00	0.60[a]	0.06	0.01	0.73[a]	0.69[a]	0.88[a]	0.75[a]	0.54	0.78[a]	0.32	0.20
5	0.60[a]	1.00	0.01	0.02	0.70[a]	0.58	0.68[a]	0.68[a]	0.44	0.68[a]	0.27	0.17
11	0.06	0.01	1.00	0.46	0.03	0.01	0.08	0.02	0.05	0.06	0.10	0.10
12	0.01	0.02	0.46	1.00	0.03	0.01	0.03	0.04	0.04	0.01	0.14	0.14
Clusters												
1	0.73[a]	0.70[a]	0.03	0.03	1.00	0.82[a]	0.74[a]	0.76[a]	0.58	0.70[a]	0.28	0.17
2	0.68[a]	0.58	0.01	0.01	0.82[a]	1.00	0.69[a]	0.83[a]	0.47	0.66[a]	0.24	0.15
3	0.88[a]	0.68[a]	0.08	0.03	0.74[a]	0.69[a]	1.00	0.75[a]	0.61[a]	0.76[a]	0.35	0.22
4	0.75[a]	0.68[a]	0.02	0.04	0.76[a]	0.83[a]	0.75[a]	1.00	0.54	0.76[a]	0.28	0.19
5	0.54	0.44	0.05	0.04	0.58	0.47	0.61[a]	0.54	1.00	0.63[a]	0.31	0.27
6	0.78[a]	0.68[a]	0.06	0.01	0.70[a]	0.66[a]	0.76[a]	0.76[a]	0.63[a]	1.00	0.43	0.35
8	0.32	0.27	0.10	0.14	0.28	0.24	0.35	0.28	0.31	0.43	1.00	0.67[a]
9	0.20	0.17	0.10	0.14	0.17	0.15	0.22	0.19	0.27	0.35	0.67[a]	1.00

[a]Correlation above .60.

demonstrated that there was a high correlation between faculty who had actually used a computer for a period of time and had written computer programs (factor 4) with all of the other adoption areas except for cluster 5 (mean time learning about and using computers). There was also a high degree of correlation between the other adoption groups, but very little correlation between perception categories or between perception categories and adoption groups. Personal perceptions about educational computer usage (cluster 8) and perceptions about computers themselves (cluster 9) were the only perception categories with a high correlation (0.67).

Analysis of Variance

The independent variables of sex (gender), age, and college of employment were analyzed with one-way analysis of variance tests in order to ascertain their relationships among adoption and perceived barrier categories. The Scheffé and Duncan multiple comparison procedures were both used in the analysis. The Scheffé method requires larger differences between means for significance and did not indicate any significant differences. However, the Duncan procedure revealed some significant differences. Table 12 illustrates significant differences at the 0.01 and 0.05 levels between sex and all adoption categories except cluster 5 (mean time spent reading about and using computers). No significant differences were found between sex and any of the perception categories. Table 13 illustrates no significant differences at the 0.05 level between age and any of the categories. Table 14 illustrates

Table 12. Analysis of variance by sex (gender)

Factor	MS_B	MS_W	F-ratio	Significance level
4	286.0	24.1	11.86	0.01
5	33.6	7.7	4.38	0.05
11	.52	.63	0.82	--
12	1.8	.5	3.48	--

Cluster	MS_B	MS_W	F-ratio	Significance level
1	69.8	9.3	7.5	0.01
2	77.6	7.1	10.91	0.01
3	96.4	19.6	4.92	0.05
4	31.7	5.2	6.13	0.05
5	2.1	.76	2.71	--
6	146.9	17.1	8.60	0.01
8	1.8	.6	3.34	--
9	.9	.6	1.67	--

Table 13. Analysis of variance by age

Factor	MS_B	MS_W	F-ratio	Significance level
4	8.2	25.1	0.32	--
5	12.0	7.7	1.56	--
11	.78	.63	1.23	--
12	.31	.51	0.60	--

Cluster	MS_B	MS_W	F-ratio	Significance level
1	3.9	9.5	0.41	--
2	10.6	7.3	1.44	--
3	7.4	19.9	0.37	--
4	8.8	5.2	1.69	--
5	.16	.77	0.21	--
6	3.2	17.7	0.18	--
8	.07	.56	0.13	--
9	.35	.57	0.61	--

Table 14. Analysis of variance by college

Factor	F-ratio	Duncan	College differences
4	0.91	--	
5	0.24	--	
11	3.71	**	7:2,3,5,6 1:5,6 4:5,6
12	1.39	**	6:7
Cluster	**F-ratio**	**Duncan**	**College differences**
1	0.81	--	
2	1.22	**	5:7
3	1.24	**	6:7
4	1.49	**	7:1,5
5	1.83	**	7:5,6
6	1.35	--	
8	1.95	**	1:7
9	0.74	--	

**Significant at the 0.05 level.

significant differences at the 0.05 level between various colleges and categories. College 7 was most often different from the other colleges. Factor 11 (economic perceptions) varied the most frequently between colleges.

Multiple Regression

Stepwise multiple correlation was used to determine if the intensity of adoption could be predicted from the perception categories, information sources, age, or sex. The four areas of computer adoption were: (1) intensity or degree of usage; (2) length of participation time in selected practices; (3) time spent learning about and using a

computer; and (4) the number of different usage practices engaged in. These four different areas of adoption represented the criteria or dependent variables for the multiple regression procedure. Each area of adoption was tested with two sets of variables. First, all of the perceived barrier categories were tested with a forward procedure, and then the sources of information, age and sex were tested in identical fashion.

The results suggested that the intensity of adoption could be predicted from a linear combination of the same two variables in all four adoption areas. These were personal biases, cluster 8, and information source usage, cluster 2. A higher amount of information source usage and a decrease in personal biases against the use of computers indicated a greater amount of computer usage. The correlation between the criterion variables and the linear combination of these two variables was between 0.57 and 0.58 for three of the areas of faculty adoption. The correlation between these two variables and the time spent learning about and using a computer (cluster 5) was 0.36. Age and sex (gender) were also found to be prediction variables for two of the areas of adoption. The data indicated a slight tendency for older males to have a greater intensity of adoption. All four of the prediction variables were significant at the 0.05 level. The results also indicated that the intensity of information source usage was the most important single prediction variable of faculty adoption. Table 15 summarizes the results of the multiple regression procedure.

Table 15. Multiple regression and faculty computer adoption

Variables	R^2	F	DF	B	SE B	Beta	T	Sig T	Signif F
Mean time of computer practice usage (Cluster 4)									
CL 8	0.08	26.7	1,296	-.249	0.12	-0.08	-2.10	0.04	0.00
CL 2	0.57	204	2,295	0.55	0.03	0.73	18.70	0.00	0.00
Age	0.58	139	3,294	0.03	0.01	0.08	2.20	0.02	0.00
Mean time spent learning about or using a computer (Cluster 5)									
CL 8	0.09	30.4	1,296	1.18	0.06	-0.15	-3.10	0.00	0.00
CL 2	0.36	82.3	2,295	0.15	0.01	0.53	11.12	0.00	0.00
Number of different usage practices engaged in (Cluster 6)									
CL 8	0.19	68.6	1,296	-1.50	0.23	-0.27	-6.70	0.00	0.00
CL 2	0.56	189	2,295	0.84	0.06	0.62	15.20	0.00	0.00
Sex	0.57	130	3,294	-0.83	0.03	-0.10	-2.50	0.01	0.00
Intensity of computer practice usage (Cluster 3)									
CL 8	0.13	44.5	1,296	0.96	0.23	-0.16	-4.10	0.00	0.00
CL 2	0.58	206	2,295	1.01	0.06	0.70	18.10	0.00	0.00

Findings Relevant to the Hypotheses

Hypothesis 1: There is no significant relationship between perceived institutional economic barriers and faculty adoption.

The variables which constituted perceived institutional economic barriers were survey questions 2, 3, and 4. These three variables were identified through factor analysis with an Eigenvalue of 2.59 and their reliability coefficient was 0.72. These variables were also related logically. This factor (number 11) had low correlation coefficients (less than 0.5) among all areas of faculty adoption. Therefore, there is insufficient evidence to reject Hypothesis 1. No significant relationship was found between perceived institutional economic barriers and faculty adoption.

Hypothesis 2: There is no significant relationship between perceived technical barriers and faculty adoption.

The variables which constituted perceived technical barriers were survey questions 5,6, and 9. These 3 variables were identified logically and their reliability coefficient was 0.76. Their correlation coefficient was low (less than 0.5) among all areas of faculty adoption. Therefore, there is insufficient evidence to reject this hypothesis. No significant relationship was found between perceived technical barriers and faculty adoption.

Hypothesis 3: There is no significant relationship between perceived administrative barriers and faculty adoption.

The variables which constituted perceived institutional administrative barriers were survey questions 10 and 11. These two variables were identified through factor analysis with an Eigenvalue of 0.94 and their reliability coefficient was 0.63. These variables were also logically related. The correlation coefficients of this factor (number 12) were low (less than 0.5) among all of the areas of faculty adoption. Therefore, there is insufficient evidence to reject Hypothesis 3. No significant relationship was found between perceived administrative barriers and faculty adoption.

Hypothesis 4: There is no significant relationship between perceived educator barriers and faculty adoption.

The variables which constituted perceived educator barriers were survey questions 1, 13, 16, and 17. These 4 variables were identified logically and their reliability coefficient was 0.71. Their correlation coefficient was low (less than 0.5) among all areas of faculty adoption. Therefore, there is insufficient evidence to reject this hypothesis. No significant relationship was found between perceived educator barriers and faculty adoption.

Hypothesis 5: There is no significant relationship between sex (gender) and all measures of faculty adopter or educational perceived barrier groups.

The analysis of variance test demonstrated that the independent variable of sex (gender) was significantly different at the 0.05 or 0.01 level for seven of the eight areas of adoption. Therefore, there is sufficient evidence to reject this hypothesis. Significant relationships

do exist between sex (gender) and the measures of faculty adoption. However, no significant relationships existed between sex (gender) and educational perceived barrier groups.

Hypothesis 6: There is no significant relationship between age and all measures of faculty adoption or educational perceived barrier groups.

The analysis of variance test demonstrated that the independent variable of age was not significantly different at the 0.05 or 0.01 level for any of the eight areas of adoption or perceived barrier groups. Therefore, there is insufficient evidence to reject hypothesis number 6. No significant relationship exists between age and all measures of faculty adoption or educational perceived barrier groups.

Summary

Chapter IV has summarized the findings of the study. All of the objectives of the research study were met. These were: (1) To describe faculty computer usage practices and the degree of adoption of these practices. (2) To describe the factors that are perceived to either facilitate or serve as barriers to the adoption and diffusion of computers for instructional purposes. (3) To examine the interrelationships among the factors that effect the adoption and diffusion of computers for instructional purposes. (4) To examine the relationships between perceived factors and faculty computer practices. (5) To describe the areas of faculty intensity of adoption from the self-reported computer usage practices.

Five of the six hypotheses were accepted when no significant relationships were found between areas of adoption, perceived barriers to the adoption of computers, and the independent variable age. Hypothesis 5 was rejected because significant differences were found between the variable sex (gender) and seven of the areas of adoption. Although no significant differences were found between sex and perceived barrier groups, there were significant differences between males and females regarding their use of a computer, the information sources used, and the number of years of usage. No relationships existed between sex (gender) and the time spent reading or learning about computers.

CHAPTER V. DISCUSSION, CONCLUSIONS, RECOMMENDATIONS

Summary

There have been numerous predictions in recent years that educational technology would revolutionize instruction in higher education. However, this has not occurred, and various authors have concluded that barriers or inhibitors of varying origins have prevented the adoption and diffusion of innovation for instructional planning and use. This study was conducted to examine and describe the relationships that exist between perceived faculty barriers and the degree to which they influence the adoption of computers for instructional purposes in higher education.

The objectives of this study were to: (1) describe faculty computer usage practices and the degree of adoption of these practices; (2) describe the factors that were perceived to either facilitate or serve as barriers to the adoption and diffusion of computers for instructional purposes; (3) examine the interrelationships among the factors that affect the adoption and diffusion of computers for instructional purposes; (4) examine the relationships between perceived factors and faculty computer practices; and (5) describe areas of faculty adoption from the self-reported computer usage practices.

Two sets of hypotheses were tested. It was hypothesized in the first set that no significant relationships existed between the areas of faculty adoption and perceived faculty barriers toward the adoption of computers. The four potential barriers examined were institutional

economic barriers, technical barriers about the innovation itself, administrative barriers toward educational computing, and educator biases about the use of computers. The second set of hypotheses stated that no significant relationships existed between the independent variables of age or sex (gender), and faculty computer adoption or perceived barriers.

The source of information for this study was a questionnaire designed by the investigator. The survey instrument was divided into four main sections: (1) faculty personal data; (2) faculty sources of information about computers; (3) faculty computer usage practices; and (4) faculty perceptions of possible barriers to the adoption of computers for instructional purposes. The survey instrument was distributed to all of the full-time faculty at a large metropolitan community college district. Three hundred five faculty responded to the survey.

The methods of data analysis primarily included the use of computerized statistical tests. These tests included frequencies, factor analysis, reliability, correlation, analysis of variance and multiple regression. Several areas of faculty computer adoption were established and compared to faculty perceptions of possible barriers about the use of computers for instructional purposes. The areas of adoption were compared to the faculty perception groups in order to test the first set of hypotheses. The independent variables of age and sex were compared to both the areas of adoption and perceived barrier groups to test the second set of hypotheses.

Conclusions

The hypotheses test results can be summarized as follows: (1) There is no significant relationship between perceived institutional economic barriers and faculty adoption. (2) There is no significant relationship between perceived administrative barriers and faculty adoption. (3) There is no significant relationship between perceived technical barriers and faculty adoption. (4) There is no significant relationship between perceived educator barriers and faculty adoption. (5) There is no significant relationship between age and perceived barriers or faculty adoption. (6) There are significant differences between sex (gender) and faculty adoption, but there are no significant differences between sex (gender) and faculty perceived barriers.

An evaluation of the findings of this study concluded that the perceptions of faculty in the areas of institutional economic climate, technical, administrative, and educator have little or no relationship to the degree of adoption of computers for instructional purposes. In addition, there is little or no relationship between age and the adoption of computers for instructional purposes. However, the study did demonstrate that there is a significant difference between sex (gender) and the adoption of computers for instructional purposes. The multiple regression analysis indicated that the degree or intensity of computer adoption can be predicted from a combination of faculty attitudes about computer usage and the degree of computer information source usage.

Recommendations

The purpose of this study was to identify the relationships between selected computer practices of community college faculty and their perceived barriers to the adoption of computers for instructional purposes. The barriers to the adoption of computers examined in this study were defined from the four general categories of Rose (1982). The areas of adoption for faculty computer practices were based on the usage of selected variables and the dates which the adoption began.

The data collected for this study included a large percent of non-adopters (22%) and were included in the study. One recommendation is to replicate and extend this research examining the non-adopter potential barrier perceptions to the areas of adoption. No significant relationships were found in this study between perception barriers and the degree of faculty adoption. However, it is possible that non-adopter perception barrier groups could produce different results. In addition, the data from this study could also be reorganized or revised in future studies to profile categories of adopters in a fashion similar to the work of Rogers et al. (1971). Similar hypotheses could then be tested according to adopter categories.

This study intentionally used several areas of adoption for its hypotheses tests because it was not certain if there was a single best measure. The findings of this study demonstrated that the comparison between all of the areas of adoption and the perception barrier groups produced similar results. Similar studies could reduce the number of adoption areas and still achieve similar results. Serious consideration

should be given to the use of counting the number of computer practices in which the faculty have participated. This group (cluster 6 in Chapter IV) was used in this study and provided an area of adoption intensity which has been supported by recent research (Abd-ella, Holberg, & Warren, 1981). This intensity of adoption area produced test results similar to the other areas of adoption but was not used as the sole area of adoption in this study. The reason for this was that its use required the altering of a continuous variable to a category variable, a procedure which is susceptible to statistical criticism.

Finally, agents of change within institutions of higher education should not readily assume that faculty perceptions about the institution's economic climate or administrative attitudes toward educational computing represent barriers to the adoption of computers. Nor should they readily assume that the complexity of computers or faculty biases toward the use of computers represent barriers to the adoption of computers for instructional purposes. This study has demonstrated that faculty perceptions in these areas do not represent significant barriers. However, the review of the literature has also demonstrated that there is a universe of factors which may affect the adoption of innovation in educational institutions. It is, therefore, recommended that agents of change give careful consideration to many factors and variables prior to the instigation of educational change.

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APPENDIX A. SURVEY QUESTIONNAIRE

I. General Information

1. Your College: _____
2. Your Age in Years: _____
3. Your Sex: _____

II. Faculty Computer Practices

Please complete this section in terms of what YOU do or have not done. If you cannot recall certain items exactly, please enter your best guess.

A. Where do you or did you find information about computers? Please enter your estimate of HOW MANY times under the number column and your estimation of the YEAR this FIRST OCCURRED under the date column.

		NUMBER	DATE
1.	Different computer journals or magazines subscribed to	.....	.....
2.	Computer books or manuals read	.....	.....
3.	Formal college computer classes taken	.....	.....
4.	College computer workshops/seminars attended	.....	.....
5.	Commercial computer seminars attended	.....	.....
6.	Salesman computer sessions attended	.....	.....
7.	Member of a computer user group	.....	.....
8.	Computer-related sessions attended at professional meetings	.....	.....

B. Do you or have you engaged in the following activities?

		NUMBER	DATE
9.	Owner of a home computer	.....	.....
10.	Computer programs written for any purpose	.....	.....
11.	Computer programs written for classroom use	.....	.....
12.	Modified programs for classroom use	.....	.....
13.	Purchased computer programs for any purpose	.....	.....
14.	Attended state/national computer meetings	.....	.....
15.	Member of computer-related committees	.....	.....
16.	Actively searched for educational software	.....	.....
17.	Used computer for classroom demonstration	.....	.....
18.	Used computer to manage student information	.....	.....
19.	Used computer for word processing	.....	.....
20.	Given assignments requiring a computer	.....	.....
21.	Formal request to college for computers	.....	.....
22.	Formal request to college for software	.....	.....
23.	Average number of minutes per week spent reading or learning about computers	.....	.....
24.	Average number of hours per month spent actually using a computer	.....	.....

III. Your Perception or Beliefs

Please circle your choice for strongly agree (SA), agree (A), undecided (U), disagree (D), strongly disagree (SD)

1. It is important to incorporate the use of computers into teaching and student learning as soon as possible. SA A U D SD
2. A main reason why computers aren't used more is that my college does not have money to purchase them. SA A U D SD
3. A main reason why computers aren't used more is that my college administration doesn't recognize the need to make computer funds available. SA A U D SD
4. My college administration is ready to make an on-going commitment of money and resources for computer education. SA A U D SD
5. Compared to traditional methods of instruction and student learning, there are some real advantages in using a computer. SA A U D SD
6. Based on my previous experiences, I don't believe that computers will improve the quality of education. SA A U D SD
7. Computers are very complex and, therefore, it is very difficult to learn how to use one. SA A U D SD
8. A main reason why computers aren't used more is that one is rarely available for use. SA A U D SD
9. It is easy for me to understand the value and benefits of using computers for instructional purposes. SA A U D SD
10. My college administration is ready and willing to support and reward faculty who use computers. SA A U D SD
11. My college administration is encouraging me to use computers for instructional purposes. SA A U D SD
12. Plans or processes for computer usage and support must be established within my division or college before I am willing to become more involved with computers. SA A U D SD
13. I am very interested in using computers for instructional purposes. SA A U D SD
14. I will need technical software and/or hardware assistance before I can effectively use a computer for instructional purposes. SA A U D SD
15. I'm worried that computers will replace classroom teachers or require them to radically change their role. SA A U D SD
16. I would much prefer not to use a computer as a teaching aid because my present methods of instruction are good enough. SA A U D SD

17. Learning about and using computers in the classroom requires more time than I have available. SA A U D SD
18. The use of computers for classroom purposes depends greatly on administrative or collective decisions by people other than myself. SA A U D SD

APPENDIX B. SURVEY COVER LETTER

Dear Faculty Member,

As a fellow employee, I'm sending you this letter as an appeal for your assistance. Your responses to the attached questionnaire will help me obtain information for my dissertation study at Iowa State University. The results will also be useful to me and others as we broaden our use of computers in instructional settings. Would you please take approximately 15 minutes out of your busy schedule to answer the following questions? Of course, all individual responses will be kept strictly confidential. Your assistance is greatly appreciated and many thanks for your help!

Would you please return the questionnaire within one week through our local mail to the following address:

Denny Anderson
xxxxxxxxxxxxxx
xxxxxxxxxxxxxx

Sincerely,

Denny Anderson

P.S. I would be more than happy to share the results of the survey with you. If you are interested, please send me a note with your name and address.

APPENDIX C. FOLLOW-UP LETTER

JUST A REMINDER

November 21

Dear Faculty Member,

On November 14th I mailed you a questionnaire which was designed to help me obtain information for my dissertation study. If you have not had the opportunity or time to complete the questionnaire, I would like to ask for your assistance again. I know how busy your schedule is, but I hope you can spare 15 minutes for this effort. Your individual response is not only important to me, but I also believe that the information will be of value to all of us in the district as we continue to plan for the use of computers in education.

Thanks again for your assistance.

Sincerely,

Denny Anderson
xxxxxxxxxxxxxx
xxxxxxxxxxxxxx