THE DIFFUSION OF WIRELESS INTERNET TECHNOLOGY AMONG UNIVERSITY FACULTY MEMBERS

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This dissertation entitled
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by

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The purpose of this qualitative study is to investigate and understand the factors that influence the diffusion of wireless Internet technology among university faculty members. Rogers’ diffusion theory provides the theoretical framework to guide the study in these aspects: perceived attributes of the wireless technology, the innovation-decision process, adopters’ categories and communication channels, and institutional factors. The study also examines the wireless teaching practices, classroom etiquette and changing pedagogy, and the roles of administrators in the technology diffusion.

Multiple sources of information were used to collect data: in-depth semi-structured interviews, observations, and documentation analysis. Qualitative data analysis techniques were used to analyze data. The participants were 16 faculty members (9 adopters and 7 non-adopters) from 6 colleges, and 7 administrators from IT department at a large Midwestern state university.

Findings from this study show that there are differences between early adopters and non-adopters (the mainstream). They are different in these aspects: knowledge and skill of technology, teaching practices, teaching philosophy, technology needs, communication channels, and characteristics. They have different perceptions toward the wireless technology and they are at different diffusion stages. Therefore, these differences lead to a diffusion “gap” between early adopters and non-adopters.
This diffusion gap implies that a different support infrastructure is needed for mainstream faculty to integrate technology for teaching and learning. An institution needs to act as a change agent to provide additional training, support and personnel, modify the reward system, provide a technological infrastructure, encourage interpersonal communication channels, and capitalize on the knowledge and skills of early adopters and opinion leaders to promote further adoption by the mainstream.

Approved:

Sandra Turner

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CHAPTER ONE: INTRODUCTION

Background of the Study

Wireless Internet technology is quickly gaining a foothold on many campuses as a means to achieve mobility and anywhere, anytime access. The Campus Computing Project 2003 (Green, 2003a, 2003b) conducted a national survey of information technology in U.S. higher education (Appendix D: Figure 1.1). The survey data revealed that wireless networks were an increasingly important issue across all sectors of higher education and showed “dramatic gains over the past year regarding campus planning for the deployment of wireless networks” (Green, 2003a, p. 1). Nearly four-fifths (77.2%) of the institutions participating in the 2003 survey reported that they had functioning wireless Internet technology. Boerner (2002) listed some characteristics of wireless networking on campus: mobility, installation speed and simplicity, installation flexibility, reduced cost of ownership, and scalability. According to a study at the Educause Center for Applied Research, wireless Internet “represents a user-centered shift, providing students and faculty with greater access than ever before” (ECAR Respondent Summary, 2002, p. 4).

Although wireless access to the campus network is becoming commonplace, institutions are still at the beginning stage of adoption in education. “There is plenty of potential in this technology for teaching and administration—everything from classroom management to providing network service for temporary locations” (Grush, 2002, p. 4). The potential impact of this new technology on learning and teaching is significant enough to gain our attention as researchers.
In order to understand the adoption of wireless Internet among faculty members at Ohio University, the study used Rogers’ (2003) Diffusion of Innovations theory as a framework. The study focused on the perceived attributes of wireless technology, the innovation-decision process, institutional factors, teaching strategies and models, and the roles of administrators in the diffusion of wireless technology.

Theoretical Framework


An innovation is a new idea, practice or object. In this case, the innovation is defined as the use of wireless technologies to access to the Internet. The characteristics of innovations can help in understanding the rate of diffusion. The characteristics of innovations include relative advantage, compatibility, complexity, trialability, and observability.

According to Rogers (2003), “Communication is a process in which participants create and share information with one another in order to reach a mutual understanding” (p. 5). There are two types of communication channels: mass media channels and interpersonal channels. Mass media channels are more effective in constructing
knowledge of innovations, while interpersonal channels are more effective in forming and changing attitudes toward a new idea, and thus in influencing the decision to adopt or reject a new idea (Rogers).

Time of the diffusion includes the aspects of the innovation-decision process, the adopter categories, and the adoption rate. The innovation-decision process has five steps: knowledge, persuasion, decision, implementation, and confirmation. The adopters can be classified into five categories: innovators, early adopters, early majority, late majority, and laggards. The rate of adoption is “the relative speed with which an innovation is adopted by members of a social system” (Rogers, 2003, p. 22).

A social system is a set of units interrelated to each other in joint problem-solving to accomplish a common goal. Social structure, social norms, opinion leaders and change agents are important aspects of a social system. How the units are arranged, what the members think of the innovations, and how the opinion leaders and change agents influence the followers are closely related to the diffusion process (Rogers, 2003). In this case the social system is the university and the academic departments.

Statement of the Problem

The research question is: What factors influence the diffusion of wireless Internet technology among faculty members of Ohio University? More specifically, the research addressed the following questions:

1. How is wireless Internet technology perceived by faculty members of Ohio University, both adopters and non-adopters, in terms of relative advantage, compatibility, complexity, trialability, and observability?
2. What is the innovation-decision process of faculty members who adopt or do not adopt wireless technology?

3. What institutional factors influence the diffusion process of wireless technology among faculty members?

4. What teaching strategies and models are instructors developing in wireless environments?

5. How are classroom atmosphere, etiquette, and changing pedagogy in wireless environments?

6. What roles do administrators play at Ohio University in facilitating the diffusion of wireless technology?

The Setting

The setting for this study was Ohio University, a major state university in southeast Ohio. Ohio University has one main campus and five regional campuses. Enrollment at the main campus (Athens) totaled 19,962 students (20,452 including Lifelong Learning) while 8,636 students were enrolled at regional campuses, for a total enrollment of 29,088 in Fall, 2003. Ohio University was committed to provide the technology students need to succeed in today's educational environment. As evidence of that commitment, a computer with printer and Internet access was provided in every student’s room in the residence halls (Office of Institutional Research, 2004).

In January 2002, Communication Network Services (CNS) of Ohio University started a wireless networking project (called “First Wave”), and free wireless Internet access for students, faculty, staff, and visitors was available in selected locations,
including indoor and outdoor areas. In the summer of 2004, Ohio University approved a plan to expand wireless Internet coverage to the whole campus in a two-year implementation cycle, and to “create a ubiquitous and seamless wireless computing environment” (“Wireless Future,” 2004; Wireless Deployment Sub-Committee, 2004).

Starting from Fall, 2004, The Center for Innovations in Technology for Learning (CITL) hosted a pilot seminar to incorporate wireless technology into classroom environments. The goal of the project was to help faculty begin to develop methods for using wireless tools in their teaching.

The Innovation

Communication Network Services (CNS) of Ohio University launched a wireless networking project in late 2001 (called “First Wave”), and free wireless Internet access for students, faculty, staff, and visitors was available in selected locations, including indoor and outdoor areas. The university was more than halfway to becoming a completely wireless campus in September 2005, when approximately 55% of the university’s campus had full wireless Internet coverage. Wireless Internet will be available campus-wide by July 2006 (Lipaj, 2005).

Through vendor interviews and hardware evaluation, Cisco access points (802.11b/g) and Bluesocket middle box (for authentication and authorization) were chosen and deployed on campus (Dixon, 2002; Acheson, Kelleher, Saunders & Sater, 2002). A user needs to provide a university ID and password to login to the wireless network. A Bluesocket middle box checks the login information against the central database to verify the ID and password.
Wireless networks were deployed in stages. The library, engineering and telecommunication buildings were the first few buildings to have wireless access. Then CNS received “excellent ‘buy-in’ from departments wanting to deploy wireless” (Communication Network Services, 2004a, p. 24). In the summer of 2004, the university approved the plan to expand wireless Internet coverage to the whole campus in a two-year implementation cycle, and to “create a ubiquitous and seamless wireless computing environment” (Wireless Deployment Sub-Committee, 2004). Wireless coverage was expanded and new locations are being added constantly. By summer 2006, the Athens campus will have 100% wireless coverage. The project includes indoor and outdoor spaces at Athens campus. The cost to the university averaged $4.54 per student per academic month (Communication Network Services, 2004a)

CNS thought mobility and wireless access were critical to the current generation of students. It became one of the most frequent asked technology questions from parents and students at pre-college orientation. From CNS Wireless Report (Communication Network Services, 2004a), the number of unique wireless Internet users on track surpassed 2,000 and the number of log-in approached 10,000 in the month of February 2004 (Appendix D: Figure 1.2). The data also showed the wireless use clearly linked to students: the reason for the big dip in December 2003 was that students were on winter break.

In CNS’s a presentation of “Wireless Future” (Communication Network Services, 2004a), it said “Wireless is the next wave,” and listed some benefits for student multi-tasking (p. 4), “incredible profusion of communications, multiple conversational threads,
several technologies used simultaneously, tremendous amount of social interaction, and
great concentration required.” It stated that the future wireless profile should be:

- Single mobile computing platform for voice, data and video;
- Multi-tasking integrated into the learning environment;
- Robust network providing access to educational assets from anywhere, anytime;
- Substantial, secure and reliable personal network storage; and
- High availability, easy to use communications application environment. (p. 8)

In the Fall 2004, The Center for Innovations in Technology for Learning (CITL) hosted a wireless pilot group meeting of faculty members interested in incorporating wireless technology into classroom environments. The goal of the project was “to develop and test creative teaching strategies using wireless technology, documenting related pedagogical and ethical issues” (Ohio University Wireless Pilot Group). More than 20 faculty members from different colleges and departments attended. After the meeting, they set near-term and long-term goals: “First, to develop several web-based case studies for your colleagues based on your practices and experiences…; second, to develop a proposal for designing an optimal learning space that supports wireless technologies” (Kranyik & O’Donnell, 2004).

CITL added several support applications to achieve the goals: a web site, a discussion forum, and a listserv. All of them can be accessed from the link:

Participants

This study focused on faculty members at Ohio University who were wireless Internet adopters. These faculty members included nine full-time or part-time instructors. Other research participants included seven faculty members who did not use wireless Internet. In addition, this study included seven administrators and staff members from IT support and service departments at Ohio University.

Methodology

The purpose of the study was to investigate the factors that influence the diffusion of wireless Internet among faculty members at Ohio University. Wireless Internet is such a new emerging technology that little research has focused on the diffusion process of faculty members in higher education. The study employed qualitative research methods. According to Patton (2002), the advantage of qualitative methods is that “qualitative methods typically produce a wealth of detailed information…” and “increases the depth of understanding of the cases and situation studied” (p. 14).

This study was designed to be a case study, involving one university. Data were gathered through interviews and observations. The researcher used semi-structured in-depth interviews to let the participants explain their experiences to adopt or not adopt wireless Internet. The researcher interviewed 16 faculty members, of which nine were wireless Internet users and seven were non-users. Seven administrators from Information Technology (IT) departments were also interviewed. Moreover, CITL seminars and faculty classrooms observations were conducted to examine teaching strategies faculty members used in wireless environments.
Significance of the Study

A survey (ECAR Respondent Summary, 2002) of 392 EDUCAUSE member institutions found that wireless Internet in higher education in the U.S. and Canada “has moved from an interesting curiosity to an appealing technology alternative for potential users” (p. 1). In the campus computing survey project (Green, 2003a), more than 630 chief information or technology officers at two-year and four-year public and private colleges and universities participated. The survey data revealed that wireless networks were an increasingly important issue across all sectors of higher education. Nearly four-fifths (77.2 %) of the institutions participating in the 2003 survey reported that they had functioning wireless LANs.

Although wireless Internet is becoming mainstream in higher education and many colleges and universities have full or partial implementation of wireless Internet, most studies in the literature were about how to set up wireless networks, wireless standards, cost, technical problems, security concerns, and occupant health. No studies have been found that investigate the diffusion process of wireless Internet among university faculty members.

Besides, wireless Internet has the potential to enhance teaching and learning, for example, “many institutions believe this access will encourage greater collaboration, resulting in better learning, research and creative scholarship” (ECAR Respondent Summary, 2002). However, not many faculty members have taken advantage of the technology and integrated it into their teaching and curriculum (Lu, Ma & Turner, 2004).
The study focused on the innovation-decision process of faculty members to identify factors that influenced their decision to adopt or not adopt wireless Internet in their academic endeavors. It also investigated the attributes of wireless technology in higher education and examined teaching strategies and models faculty members were developing in wireless environments. Good learning models and practices can serve as motivation for faculty members to adopt the wireless technology.

No technology adoption can achieve success without sustainable commitments from administrators. The study can inform administrators about what could be done to encourage more faculty members to adopt wireless Internet and what professional development activities facilitate the diffusion of wireless technology in teaching and the curriculum.

The findings suggest what factors affect the diffusion of wireless technology in a university or a college, and how to solve the problems and increase the adoption rate. Educators and administrators are the audience of the implications.

Limitations and Delimitations of the Study

This study was conducted at Ohio University and the participants were the faculty members at Ohio University who had either adopted or not yet adopted wireless Internet. The choice of the research location and participants might be a limitation for the study because Ohio University might exhibit a structure and culture either supporting or inhibiting the diffusion of wireless Internet that is different from other universities.

In addition, Ohio University was in the early stages of adoption of wireless Internet technology. Wireless Internet did not cover all the buildings and classrooms on
campus, which limited faculty members’ ability to access and adopt the technology and affected the number of early adopters among faculty members.

One of the shortcomings of diffusion research is its pro-innovation bias. The pro-innovation bias is “the implication in diffusion research that an innovation should be diffused and adopted by all members of a social system, that it should be diffused more rapidly, and that the innovation should be neither re-invented nor rejected” (Rogers, 2003, p. 106). The researcher acknowledged the pro-innovation bias in this study. The researcher tried to see the wireless technology through the eyes of both adopters and non-adopters and understand the non-adopters’ rationale and appropriate behaviors and decisions toward the technology.

A frequently cited limitation of a case study methodology is generalizability. This study makes no generalizations of all faculty members or all universities and colleges. However, the unique case can have significant suggestions for other entities. Many universities and colleges are conducting wireless projects and the wireless technology is becoming mainstream in higher education. The case of Ohio University might suggest similar factors that may influence the diffusion process of wireless technology among faculty members at other universities or colleges. Case study method is used in this research because its findings often resonate experientially or phenomenologically with a broad cross section of readers and thus facilitate greater understanding of the phenomenon in question (Feagin, Orum & Sjoberg, 1991).
Definitions of Terms

**Access points**: Wireless access points, also known as “base stations,” play a central role in a wireless LAN. Generally mounted on walls or ceilings to minimize interference, they house radio transmitters and receivers that connect client computers, equipped with wireless adapters, to the network. Since data rates decline as more users connect or as users move further from an access point, building-wide systems generally require multiple access points (Hammond & Salpeter, n.d., p. 2).

**Adopter categories**: Classifications of the members of a social system on the basis of their innovativeness (Rogers, 2003, p. 473).

**Adoption**: A decision to make full use of an innovation as the best course of action available (Rogers, 2003, p. 473).

**BlackBoard**: A web-based software system which is used to support flexible teaching and learning in face-to-face and distance courses. It provides tools and facilities for online course management, content management and sharing, assessment management, and online collaboration and communication (BlackBoard, 2005).

**Change agent**: An individual who influences clients’ innovation-decisions in a direction deemed desirable by a change agency (Rogers, 2003, p. 27).

**Communication channels**: the means by which messages get from one individual to another (Rogers, 2003, p. 18).

**Diffusion**: The process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003, p. 5).
Innovation: An idea, practice or object that is perceived as new by an individual or other unit of adoption (Rogers, 2003, p. 12)

Innovation-decision process: The process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation and use of the new idea, and to confirmation of this decision (Rogers, 2003, p. 475).

Interpersonal channels: A face-to-face exchange between two or more individuals (Rogers, 2003, p. 18).

Mass media channels: All those means of transmitting messages that involve a mass medium, such as radio, television, newspapers, and so on, which enable one or a few individuals to reach an audience of many (Rogers, 2003, p. 18).

Networking cards/adapters: The communication between a computer and a wireless LAN access point is generally enabled by a PC Card (for laptops) or a PCI card (for desktops). In some situations the network adapter is built in to the model or is available as an external unit connected to a computer port (Hammond & Salpeter, n.d., p. 2)

Opinion leaders: Members of the social system in which they exert their influence (Rogers, 2003, p. 27).

Social system: A set of interrelated units that are engaged in joint problem solving to accomplish a common goal (Rogers, 2003, p. 23).

Uncertainty: The degree to which a number of alternatives are perceived with respect to the occurrence of an event and the relative probabilities of these alternatives (Rogers, 2003, p. 476).
**Wireless Internet:** The use of wireless communications technologies to access network-based information and applications from mobile devices (Technology Forecast: 2001-200, 2001, p. 5).

**WLAN:** A wireless local area network (WLAN) connects computers and peripherals within a building or campus. Generally schools and businesses use WLANs in conjunction with wired WANs and LANs to extend the network (Hammond & Salpeter, n.d., p. 2).
CHAPTER 2: LITERATURE REVIEW

This literature review examined three strands of theories and research. The first strand discussed Rogers’ Diffusion of Innovations, which is the theoretical framework for the research. The second strand examined factors that impeded or facilitated educational technology diffusion and implementation. The last strand examined research of wireless Internet in higher education.

Rogers’ Diffusion of Innovations

One model for understanding technology diffusion is Everett Rogers’ (2003) theory of the diffusion of innovations. Rogers (2003, p. 5) defined diffusion as “the process by which an innovation is communicated through certain channels over time among the members of a social system.” Based on the definition of diffusion, Rogers identified four major elements of diffusion: an innovation, communication channels, time (the innovation-decision process, the adopter categories, and the adoption rate), and the social system. The process of adoption consists of a series of actions and choices over time, based on internal factors within a social system.

The Attributes of Innovation

Rogers (2003) defined an innovation as “an idea, practice or object that is perceived as new by an individual or other unit of adoption” (p. 12). For instructional innovations, the innovation can be defined as instructional technology for teaching and learning, and diffusion as the extent that faculty have adopted this innovation (Jacobsen, 1998).
The perceived attributes of innovations can help in understanding the rate of diffusion. Rogers (2003) outlined five distinct attributes that are strong predictors of an innovation's acceptance: relative advantage, compatibility, complexity, trialability, and observability. Relative advantage, compatibility, trialability, and observability are usually positively related to the rate of adoption, while complexity is usually negatively related to the rate of adoption (Rogers, 2003).

**Relative Advantage**

Relative advantage is “the degree to which an innovation is perceived as better than the idea that it supersedes” (Rogers, 2003, p. 229). Relative advantage indicates the benefits and costs resulting from adoption of an innovation and is one of the best predictors of an innovation’s rate of adoption. The perceived relative advantage of an innovation is usually related to its rate of adoption in a positive direction. It means that “the greater the perceived relative advantage of an innovation, the more rapid its rate of adoption will be” (Roger, 2003, p.15)

The degree of relative advantage can be expressed as economic factors, social motivations, incentives, and other benefits. Economic factors refer to a technological advance or advances resulting in a reduced cost of production that lead to a lower price for consumers. A rapid rate of adoption will occur when the price of a new product decreases during its diffusion process (Rogers, 2003). Status motivation is the desire to gain social status among adopters. Status motivations seem to be more important for innovators, early adopters, and the early majority, and less important for the late majority and laggards (Rogers, 2003). Incentives refer to “direct or indirect payments of either
Incentives can increase the rate of adoption of an innovation because adopter incentives increase relative advantage, and diffuser incentives increase observability. Adopter incentives also can “lead to adoption of an innovation by individuals different from those who would otherwise adopt” (Rogers, 2003, p. 238).

**Compatibility**

Compatibility is “the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters” (Rogers, 2003, p. 240). The perceived compatibility of an innovation is positively related to its rate of adoption. Compatibility is the key factor for all innovations, even those with a high relative advantage. If the idea seems morally irreconcilable, then the innovation will not be adopted. An innovation must be considered socially acceptable to be implemented. Rogers (2003) stated that an innovation could be compatible or incompatible with sociocultural values and beliefs, previously introduced ideas, or client needs.

**Complexity**

Complexity is “the degree to which an innovation is perceived as difficult to understand and use” (Rogers, 2003, p. 257). The perceived complexity of an innovation is generally related to its rate of adoption in a negative direction. Some innovations are
easily understood by most members of a social system and will be adopted quickly, whereas others may be more complicated and will be adopted more slowly (Rogers, 2003).

**Trialability**

Trialability is “the degree to which an innovation may be experimented with on a limited basis” (Rogers, 2003, p. 258). Innovations that are trialable represent less uncertainty and will generally be adopted more rapidly than innovations that are not divisible. Thus, the perceived trialability of an innovation is usually positively related to its rate of adoption. The trialability is more important for earlier adopters than later adopters because earlier adopters have no precedent to follow when they adopt, while later adopters are “surrounded by peers who have already adopted the innovation” and “these peers act as a kind of vicarious trial for later adopters” (Rogers, 2003, p. 258).

**Observability**

Observability is “the degree to which the results of an innovation are visible to others” (Rogers, 2003, p. 258). The perceived observability is related to the rate of adoption in a positive direction. The easier an innovation is for individuals to see the results of an innovation, the more likely they are to adopt it. According to Rogers (2003), a technology has two components: a hardware aspect that “consists of the tool that embodies the technology as material or physical objects”, and a software aspect that “consists of the information base for the tool” (p. 259). Since software component of a technology is not so apparent, innovations in which the software is dominant are less observable and have a slower rate of adoption.
Therefore, Rogers (2003) argued that “innovations that are perceived by individuals as having greater relative advantage, compatibility, trialability, observability, and less complexity will be adopted more rapidly than other innovations” (p. 16). In the case of educational technologies, the characteristics and attributes of using the technology must be clear. The relative advantage might be increasing student access to class information or helping students become independent, lifelong learners. The technology needs to be compatible or familiar with existing systems on campus. For example, Internet technologies can be integrated with the campus website. The technology must be simple to use and understand. It should be accessible for experimenting without risk of failure and with no requirements to adopt it. New technology needs to be observable; it is essential for teachers to be able to see the technology in action (Lewis & Orton, 2000).

*Communication Channels*

Information plays a vital role in the diffusion of innovations in that individuals must be aware of the existence and relevance of an innovation in order to decide to adopt or reject it. According to Rogers (2003), “A communication channel is the means by which messages get from one individual to another” (p. 18). There are mass media channels and interpersonal channels.

Mass media channels refer to “all those means of transmitting messages that involve a mass medium, such as radio, television, newspapers, and so on, which enable one or a few individuals to reach an audience of many” (Rogers, 2003, p. 18). Mass media channels create awareness, disseminate hardware (information about the innovation), software (information about how the innovation works), and innovation-
evaluation (information about how well the innovation works) messages, and provide feedback to potential adopters about those who have adopted. Because they create awareness, mass communications place some pressure upon opinion leaders to make decisions about the new technology (Rogers, 2003).

Interpersonal channels refer to “a face-to-face exchange between two or more individuals” (Rogers, 2003, p. 18). Interpersonal communications between experts and the public, opinion leaders and the public, and among friends and family are equally as essential as mass communications in bringing about new technology adoption. Knowing the viewpoints of opinion leaders and others (family and friends) is a critical element of the social comparison process leading to choice shift (Rogers, 2003).

The mass media’s most powerful effect on diffusion is that it spreads knowledge of innovations to a large audience rapidly. It can even lead to changes in weakly held attitudes. But strong interpersonal ties are usually more effective in the formation and change of strongly held attitudes. Research has shown that firm attitudes are developed through communication exchanges about the innovation with peers and opinion leaders. These channels are more trusted and have greater effectiveness in dealing with resistance or apathy on the part of the adopters (Rogers, 2003).

*The Innovation-Decision Process*

Rogers (2003, p. 20) defined the innovation-decision process as:

The process through which an individual (or other decision-making unit) passes (1) from first knowledge of an innovation, (2) to forming an attitude toward the
innovation, (3) to a decision to adopt or reject, (4) to implementation and use of the new idea, and (5) to confirmation of this decision.

Rogers (2003) stated that “the innovation-decision process is an information-seeking and information-processing activity in which an individual obtains information in order to decrease uncertainty about the innovation” (p. 21). The innovation-decision process comprises a series of stages through which potential adopters pass as they move from seeking information about the innovation, to making a decision to adopt or reject, and finally, to confirmation of their adoption decision. Rogers (2003) established a model of the innovation-decision process that has five stages: knowledge, persuasion, decision, implementation, and confirmation.

Knowledge Stage

The knowledge stage is the beginning stage of the innovation-decision process and “occurs when an individual (or other decision-making unit) is exposed to an innovation’s existence and gains some understanding of how it functions” (Rogers, 2003, p. 169).

At the knowledge stage, an individual mainly seeks software information about an innovation. The individual wants to know what the innovation is, and how and why it works. According to Rogers (2003), there are three types of knowledge, awareness-knowledge, how-to knowledge, and principles-knowledge. Awareness-knowledge refers to “information that an innovation exists” (p. 173). It answers the question “What is the innovation?” and then motivates an individual to seek how-to knowledge and principle knowledge. How-to knowledge consists of “information necessary to use an innovation
properly” (p. 173). It answers the question “How does it work?” Principle-knowledge refers to “information dealing with the functioning principles underlying how an innovation works” (p. 173). It answers the question “why does it work?”

Mass media channels play an important role in transmitting such software information. Most often, potential adopters become aware of the innovation through mass media messages distributed by news outlets, trade journals, internet web sites, and scientific publications (Rogers, 2003).

**Persuasion Stage**

The persuasion stage is the stage when “the individual (or some other decision-making unit) forms a favorable or unfavorable attitude toward the innovation” (Rogers, 2003, p. 174). The mental activity at the persuasion stage is affective (or feeling), while the mental activity at the knowledge stage is mainly cognitive (or knowing). At this stage, the individual becomes psychologically involved with the innovation. The perceived attributes of an innovation, such as relative advantage, compatibility, and complexity, are particularly important at this stage.

At the persuasion stage, an individual also seeks information to reduce uncertainty about an innovation’s expected consequences. Mass media channels are too general to provide this specific kind of information, whereas interpersonal networks with near-peers are particularly likely to convey this kind of information.
**Decision Stage**

The decision stage takes place “when an individual (or other decision-making unit) engages in activities that lead to a choice to adopt or reject an innovation” (Rogers, 2003, p. 177).

The trialability attribute of an innovation is especially important at this stage because most individuals will not adopt an innovation without trying it first in order to determine its usefulness. Thus, innovations that can be divided for trial are generally adopted more rapidly.

**Implementation Stage**

The implementation stage is the stage “when an individual (or other decision-making unit) puts an innovation to use” (Rogers, 2003, p. 179). This stage involves obvious behavior changes and actually puts a new idea into practice.

The implementation stage often entails re-invention, which is defined as “the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation” (Rogers, 2003, p. 180). Adopters alter the new technology to fit their specific needs.

The implementation stage may represent the termination of the innovation-decision process for most individuals, but for others, a confirmation stage may occur (Rogers, 2003).

**Confirmation Stage**

The confirmation stage occurs when an individual (or other decision-making unit), is exposed to conflicting messages about an innovation, seeks reinforcement of an
innovation-decision that has already been made, or reverses a previous decision to adopt or reject the innovation (Rogers, 2003).

The dissonance reduction is very important for the confirmation stage. Once a difficult decision has been made, the adopter finds it psychologically satisfying to accentuate the good reasons for making the decision to adopt. Adopters of complex, controversial technologies, therefore, often look for signals that their decision is the correct one. A good change agent will reinforce the decision and seek ways to facilitate the transition to using the new technology (Rogers, 2003).

Discontinuance, a decision to reject a technology, can occur anytime during confirmation. There are two types of discontinuance: (1) Replacement discontinuance occurs when a better innovation is introduced and adopted. (2) Disenchantment discontinuance results when problems arise with the design or usefulness of the innovation that were not anticipated (Rogers, 2003).

**Adopter Categories as Ideal Types**

From the innovation-decision process, we know that individuals (or other decision-making units) do not adopt or reject an innovation at the same time. Therefore, there are different categories of adopters depending on the degree to which an individual is relatively earlier in adopting an innovation than other members of a social system.

Each individual’s innovation-decision is largely framed by personal characteristics and this diversity is what makes diffusion possible. For a successful innovation, the adopter distributions follow a bell-shaped curve when diffused over time on a frequency basis (Appendix D: Figure 2.1). Diffusion scholars divide this bell-shaped
curve to characterize the five categories of system member innovativeness, where innovativeness is defined as the degree to which an individual is relatively earlier in adopting new ideas than other members of a system. These groups are: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, and 5) laggards. The five adopter categories are “ideal types,” which are “based on abstractions from empirical investigations.” Exceptions to the ideals types can be found (Rogers, 2003, p. 282).

**Innovators: Venturesome**

Innovators are people who are considered risk takers and usually enjoy technology for its own sake (2-3% of the population). Innovators are venturesome types and “their interests in new ideas leads them out of a local circle of peer networks and into more cosmopolite social relationships” (Rogers, 2003, p. 282). Innovators must be able to cope with a high degree of uncertainty about an innovation at the time of adoption. According to Rogers (2003), while innovators may not be respected by other members, they play an important role in the diffusion process: launching the new idea by importing the innovation from outside of the system’s boundaries. Thus, “the innovator plays a gatekeeping role in the flow of new ideas into a system” (p. 283)

**Early Adopters: Respect**

Early Adopters are those who are able to adopt a technology to a specific situation that is important to them (13-14% of the population). “Early adopters are a more integrated part of the local system than are innovators” (Rogers, 2003, p. 283). Early adopters use the data provided by the innovators’ implementation and confirmation of the innovation to make their own adoption decisions. This group earns respect for its
judicious, well-informed decision-making and they serve as a role model for many other members of a social system. Rogers (2003) stated that “early adopters help trigger the critical mass when they adopt an innovation” (p. 283).

*Early Majority: Deliberate*

The early majority are the pragmatists who are willing to adopt a thoroughly tested technology if they easily see the advantages of using that technology (34% of the population). The early majority adopters deliberate for some time before completely adopting a new innovation. The early majority’s unique position between the very early and the relatively late adopters places them in a linking role in the diffusion process. They provide interconnectedness in the system’s interpersonal networks. Although the early majority adopters interact frequently with their peers, they “seldom hold positions of opinion leadership in a system” (Rogers, 2003, p. 283).

*Late Majority: Skeptical*

The late majority are skeptical of an innovation and reluctant to accept it (34% of the population). They may adopt an innovation when facing both an economic necessity and increasing peer pressure. When the late majority are convinced to adopt an innovation, the weight of system norms must definitely favor an innovation (Rogers, 2003).

*Laggards: Traditional*

Laggards resist technology and consistently question the use of technology (16% of the population). The last adopters, laggards, can either be very traditional or be isolates in their social system. If they are traditional, they are suspicious of innovations and often
interact with others who also have traditional values. If they are isolates, their lack of social interaction decreases their awareness of an innovation’s demonstrated benefits. It takes much longer than average for laggards to adopt innovations (Rogers, 2003).

**The Gap between Early Adopters and the Mainstream**

Rogers (2003) said that the time element of the diffusion process allows us to classify adopter categories and to draw diffusion curves. The adoption of an innovation usually follows a normal, bell-shaped curve when plotted over time on a frequency basis. The segment of the diffusion curve between 10 to 20 percent adoption is the “heart of the diffusion process,” and represents the transition from the “early adopter” to the “early majority.” He commented that “the S-shaped curve of diffusion “takes off” once interpersonal networks become activated in spreading individuals’ subjective evaluation of an innovation from peer to peer in a system” (p. 274). The point is “critical mass,” which “occurs at the point at which enough individuals in a system have adopted an innovation so that the innovation’s further rate of adoption becomes self-sustaining” (p. 343) (Appendix D: Figure 2.2).

Moore (1999) called the gap a “chasm” in his book Crossing the Chasm. The early majority and late majority comprise the “mainstream.” “Chasm” was defined as the gap between “visionaries,” early adopters who seize on new gadgets, and more mainstream “pragmatists” who need convincing before they adopt it. Moore extended Rogers’ adopter diffusion model, and added a gap between early adopters and early majority (Appendix D: Figure 2.3).
The Social System

Diffusion of innovations is inherently a social process. Diffusion takes place within the context of structures of social relationships based upon power, norms, and public acceptability. Rogers (2003) defined a social system as "a set of interrelated units that are engaged in joint problem solving to accomplish a common goal" (p. 23). Social structure, social norms, types of innovation-decision, opinion leaders and change agents are important aspects of a social system. How the units are arranged, what the members think of the innovations, and how the opinion leaders and change agents influence the followers are closely related to the diffusion process.

Types of Innovation Decisions

Rogers (2003) explained three types of innovation decisions. Optional innovation-decisions are “choices to adopt or reject an innovation that are made by an individual independent of the decisions of the other members of the system” (p. 28). Even in this case, the individual’s decision may be influenced by the norms of the social system and interpersonal communications. Second, collective innovation-decisions refer to “choices to adopt or reject an innovation that are made by consensus among the members of a system” (p. 28). Third, authority innovation-decisions are “choices to adopt or reject an innovation that are made by relatively few individuals in a system who possess power, status, or technical expertise” (p. 29). In this situation, an individual has little or no influence in the innovation decision; he or she simply implements the decision made by an authority.
Generally, Rogers concluded that authority decisions have the fastest rate of adoption of innovation, and optional decisions can be made more rapidly than collective decisions.

**Opinion Leaders**

The important aspect of social systems is that social collectives have hierarchies; the opinions of some persons/organizations carry more weight than those of others during the social comparison process. Rogers (2003) referred to these more prestigious persons/organizations as opinion leaders. Opinion leaders have the ability to “influence other individuals’ attitudes or overt behavior informally in a desired way with relative frequency” (p. 27). The most striking characteristic of opinion leaders is their unique and influential position: they are at the center of interpersonal communication networks. Thus, it is the opinions of opinion leaders that strongly influence adoption or rejection.

**Change Agents**

A change agent is “an individual who influences clients’ innovation-decisions in a direction deemed desirable by a change agency” (Rogers, 2003, p. 27). Change agents act as links between the change agency and clients. Change agents often use opinion leaders in a social system to help the diffusion of innovations.

**Summary**

Rogers’ (2003) *Diffusion of Innovations* is the theoretical framework for the study. Diffusion is “the process by which an innovation is communicated through certain channels over time among the members of a social system” (Rogers, 2003, p. 5). These elements of diffusion will be examined in the study: the attributes of innovations, the
innovation-decision process, the adopter categories, communication channels, and the social system (Appendix D: Table 2.1). The attributes of innovations include relative advantage, compatibility, complexity, trialability, and observability. There are five stages of the innovation-decision process: knowledge stage, persuasion stage, decision stage, implementation stage, and confirmation stage. The adopter categories include innovators, early adopters, early majority, late majority, and laggards. There are mass media channels and interpersonal channels. As for the social system, the roles of opinion leaders and change agents will be examined.

Rogers’ *Diffusion of Innovations* provides key concepts and principles for the first two research questions of the study.

1. How is wireless Internet technology perceived by faculty members of Ohio University, both adopters and non-adopters, in terms of relative advantage, compatibility, complexity, trialability, and observability?
2. What is the innovation-decision process of faculty members who adopt or not adopt wireless technology?

Factors that Impede or Facilitate Technology Diffusion and Implementation

Rogers paved the way with his Diffusion of Innovations (Rogers, 1962, 1983, 1995, 2003; Rogers & Shoemaker, 1971) and diffusion theory is “a conceptual paradigm with relevance for many disciplines” (Rogers, 2003, p. 103). As particular to the educational technology field, researchers applied Rogers’ theory to examine the conditions and factors that impede or facilitate diffusion and implementation process in educational settings. This section presents several frameworks that discuss factors and
conditions that specifically affect educational technology diffusion: Farquhar and Surry’s (1997) adoption analysis, and Ely’s (1990a, 1990b, 1999a, 1999b) eight conditions that facilitate technology implementation.

_Adoption Analysis_

Farquhar and Surry (1994) developed an adoption analysis tool that can be used to examine the factors that can inhibit or enhance the adoption of a technological innovation. These factors fall into two major categories: (1) individual factors, which comprise all of the skills, attitudes, perceptions, and knowledge possessed by the individual potential adopters; and (2) organizational factors, which are all of the hardware, knowledge, attitudes, and skills that exist within the adopting organization (Appendix D: Table 2.2).

Individual factors can be further subdivided into individual user characteristics and individual perceived attributes. Individual user characteristics include (1) motivation, (2) anxiety, (3) knowledge base, (4) prior experience, and (5) skill level. Individual perceived attributes are the same five characteristics of an innovation as described by Rogers (2003), namely, (1) compatibility, (2) complexity, (3) observability, (4) relative advantage, and (5) trialability (Farquhar & Surry, 1994).

Farquhar and Surry considered organizational factors as separate variables that affect the adoption of the innovation within the social system, namely: physical environment factors and support environment factors.

The physical organizational factors are (1) patterns of use, (2) reasons for use, (3) classroom facilities, (4) student-user characteristics, and (5) administrator characteristics. The support environment factors comprise all of the resources and services needed to
install and maintain an instructional product, namely, (1) production services, (2) storage and delivery services, (3) dissemination resources, and (4) support resources (Farquhar & Surry, 1994).

Some factors of Farquhar and Surry’s adoption analysis were based on Rogers’ diffusion theory, such as perceived attributes. The contribution that Farquhar and Surry made was to carefully examine organizational factors that affect the adoption of an instructional product in a social system, namely: physical environment and support environment factors.

*Conditions that Facilitate Technology Implementation*

Traditionally researchers have identified barriers that impede educational technology adoption. The basic argument for identifying barriers is that “if we knew what types of resistance exist, perhaps we could design strategies to combat them” (Ely, 1999a, p. 24). Rather than looking for resistance factors, Ely took a fresh approach and looked at a successful example of technology diffusion. The question becomes “where innovations have been adopted and implemented, what were the conditions that appeared to facilitate the process?” (Ely, 1999a, p. 24). Ely reviewed the literature, including Rogers’ theory and others, and then identified “a list of factors that seemed to explain successful implementation” (Ely, 1999a, p. 24). Combining the literature review and the research he conducted with educators in Indonesia, Chile and Peru, Ely proposed a framework of eight conditions within an organization to facilitate the implementation of educational technology innovations. The eight conditions are dissatisfaction with the status quo,
existence of knowledge and skills, availability of resources, availability of time, rewards or incentives, participation, commitment, and leadership (Appendix D: Table 2.3).

1. Dissatisfaction with the status quo: an emotional discomfort that results from perceiving the current method as inefficient or ineffective. Dissatisfaction can be “an innate feeling or an induced state” (Ely, 1999a, p. 24).

2. Existence of knowledge and skills: an assessment of the current level of skills and knowledge of the product users as they relate to the innovation. Existence of knowledge and skills is “consistently near the top of the list as one of the most important factors leading to implementation” (Ely, 1999a, p. 24).

3. Availability of resources: the amount of resources currently available to successfully implement the innovation. This includes equipment, publications, audiovisual media, finances, and personnel. “The lack of systematic development of resources means that educational technology can be found only in limited locations” (Ely, 1999a, p. 32).

4. Availability of time: adequate time and compensated time for users to become educated and skilled in how to use the innovation. This condition refers not only to the organization’s willingness to provide time but the users’ willingness to devote time to learning new skills.

5. Rewards or incentives exist: the existence of incentives that motivate users to employ the innovation, or rewards provided by the organization for those who do use the innovation.
6. Participation: the involvement of key stakeholders in decisions that relate to the planning and design of the innovation.

7. Commitment: the perception by users that the powerbrokers of the organization (i.e. Presidents, CEO, Vice Presidents) actively support the implementation of the innovation.

8. Leadership: an active involvement by immediate supervisors in assisting the users in implementing the innovation.

Ely (1999b) also identified the linkages between these conditions (Appendix D: Table 2.3). He suggested that there was no emerging hierarchy to these conditions and “strength and importance emerge as functions of the context and the innovation” (p. 8). Although most of these conditions are interrelated, leadership is related to the most.

Summary

Taken together, strands one and two provide a picture of the process of technology adopt and implementation. As previously mentioned, Rogers’ diffusion theory provides principles for addressing the research questions 1 and 2 of the study. Ely’s theory about factors that facilitate technology diffusion provides guidelines for understanding research question 3 and 6.

3. What institutional factors influence the diffusion process of wireless technology among faculty members?

6. What roles do administrators play at Ohio University in facilitating the diffusion of wireless Internet?
Wireless Internet Technology

Wireless Internet in General

Technology Forecast: 2001-2003 (2001) defined wireless Internet (mobile Internet) as “the use of wireless communications technologies to access network-based information and applications from mobile devices” (2001, p. 5). “With dizzying rapidity, wireless innovations are moving from the cutting edge to the routine” (Levy, 2004, p. 33). The Mobile Wireless Outlook Report (n.d.), a comprehensive study by the Center for Telecom Management, determined that nearly half of the U.S. labor force had wireless voice, pagers, or mobile computing devices by the end of 2002. The report further estimated “one-third of the world’s population will own a wireless device by 2008” (Fife, n.d., p. 3).

Wireless Internet can keep everyone connected all the time. It also makes obtaining information more convenient than ever. Consumers and employees around the world are using wireless Internet to work, play, travel, shop, and bank. The wireless technology will change the way people work, play, and communicate (Technology Forecast: 2001-2003, 2001).

Why is wireless Internet coming into prominence at the beginning of the twenty-first century? Technology Forecast: 2001-2003 (2001) stated that the success of wireless Internet rested on the maturation of technology trends that have been under way for some time.

1. Success of mobile computing devices, such as laptops, PocketPC, and other handheld devices.
2. Ubiquity of mobile voice handsets. Since adding Internet browser software to mobile voice handsets can be done at little or no cost, the handsets will immediately become a widely available client platform to deploy wireless Internet.

3. New wireless data technologies, including the change from dial-up connections to high-speed broadband connections.

4. Success of early applications. For example, wireless messaging has proved extremely successful in China, United Kingdom, and Germany.

The wireless Internet has great promise, but there are barriers to development. Wireless networks are spotty in many areas, slower as more users use at the same time, and they are less reliable than their wired counterparts. Standards for the technology are still under development. There are also social, cultural, and institutional barriers to implement the wireless technology. The most important concerns are privacy and security issues (Technology Forecast: 2001-2003, 2001).

Wireless Internet in Higher Education

Wireless Internet opens a new dimension of computer networking in higher education. Wireless Internet is affecting not just the classroom environment and technology access, but also the actual activities of learning and teaching. Students, faculty, and staff can open their laptops in classrooms, libraries, or outdoors to use the wireless Internet. “Higher education institutions feel the impact of computing freedom throughout their operation” (Arabasz & Pirani, 2002). In the section of wireless Internet in higher education, I first provide the general picture of wireless implementation in
higher education, and then examine the following aspects of wireless Internet: reasons for implementation, adopter characteristics, student’s learning, student’s achievement, instructor’s teaching, and barriers of implementations.

The General Picture of Wireless Internet in Higher Education

There are some studies done on how higher education is implementing wireless Internet programs. EDUCAUSE Center for Applied Research (ECAR) conducted quantitative and qualitative research for a comprehensive picture of wireless LAN activity (Arabasz & Pirani, 2002; Boggs, 2002; ECAR Respondent Summary, 2002). Data collection included an online survey of 392 EDUCAUSE institutions in late 2001; follow-up, in-depth telephone and on-site interviews at 17 representative institutions in February and March, 2002; and case studies conducted at six institutions. The research found that wireless Internet is “undergoing mainstream adoption within U.S. higher education” (Arabasz & Pirani, 2002, p. 10) and “has moved from an interesting curiosity to an appealing technology alternative for potential users. Successful pilot projects are encouraging a growing number of institutions to move toward major wireless commitments” (ECAR Respondent Summary, 2002, p. 1). Many institutions began wireless networks as pilots for research and experimental purpose. They phased in their wireless networks, perhaps to test the technology in a controlled situation, handle a building’s specific requirements, or to install it as funding allowed (Arabasz & Pirani, 2002).

The ECAR Respondent Summary (2002) survey data revealed that 59% of respondents had at least limited wireless networks in place, though only 7% of those
surveyed had implemented comprehensive wireless networks. Almost all other institutions were planning wireless networks or intended to implement wireless networks. Only 6% of institutions had no plans to implement wireless networks. The research also found that three-quarters of those implementing wireless networks had done so since the start of 2001. As to the scope of implementation, the survey data revealed that 23% of respondents had a campus-wide implementation. The other institutions had specific buildings or a specific location implementation. 54% of current wireless implementers had outdoor use and 22% were planning outdoor use. As to the buildings with coverage, libraries have the highest coverage of all building types: 88% of respondents had wireless coverage of the libraries (ECAR Respondent Summary).

**Reasons for Wireless Internet Implementation**

According to the ECAR Respondent Summary (2002) study, most institutions implemented their wireless networks as a complement to current wired network operations. Dartmouth College reported: “We wanted to provide network access literally anywhere, indoors or outdoors.” Another reason for implementing wireless is to augment wired networks to provide comprehensive network access. As the University of Wisconsin Madison explained: “We had run out of space for additional computer labs. We were trying to find ways to reduce the long wait lines in our public computing labs. Since we knew 25% of the students who owned a computer had a laptop, we wondered if they would use a wireless area instead of a lab.” Others felt wireless represented a means to meet future computing needs. Florida State University reported: “The college of Law and MBA program in the College of Business wanted to deploy a laptop/wireless
initiative. Both programs indicated this was becoming the norm for teaching in their respective disciplines to benefit students and faculty.” Wake Forrest reported that they “wished not to be left behind.”

In another survey conducted by Hammond and Salpeter (n.d.), a random sampling of K-12 schools across the U.S. was asked about their plans in this arena. The research revealed that the number one benefit of wireless and mobile computing—identified by 80% of respondents—was portability. Students and faculty could bring their laptops on field trips, to home with individuals for 24-hour learning, and from class to class. The second most important reason for going wireless was to extend the network. Given the cost and difficulties involved in pulling wires and upgrading the infrastructure in older buildings, many schools preferred to add a wireless component.

According to Arabasz and Pirani’s research of *Wireless Networking in Higher Education* (2002), the leading reason for wireless Internet was the desire to provide a greater degree of anywhere, anytime network access to students. Other reasons included meeting future computing needs, and improving classroom and faculty access to networks. Overall, Arabasz and Pirani (2002) stated that “wireless is considered a success in higher education. The vast majority of institutions using wireless networks say they have met or exceeded their expectations” (p. 11).

*The Attributes of Wireless Internet in Higher Education*

Boerner (2002) listed some characteristics of wireless networking in higher education: mobility, installation speed and simplicity, installation flexibility, reduced cost of ownership, and scalability.
1. **Mobility**: The wireless Internet enables users to move from classroom to classroom, building to building, and still access the Internet, file servers, library resources, and so forth.

2. **Installation speed and simplicity**: The use of wireless in older buildings can save considerable money and challenges posed by renovating to support networking.

3. **Installation flexibility**: Flexibility is offered in both the networking of dedicated computer labs and the use of mobile computer labs. This can allow any classroom to become a computer lab, as needed, with the use of computer carts.

4. **Reduced cost of ownership**: Although mid- to high-end access points are expensive, the overall investment in the wireless infrastructure is, in the long run, less expensive than retrofitting cables into old buildings. And by not having fixed positions, rooms can be adapted for different uses in the future without writing off the cost of the wiring.

5. **Scalability**: The wireless LAN could start off small, perhaps with a mobile computer lab, and then grow in size and complexity as needed and when funds become available. Likewise, devices like access points can be upgraded when the instructional needs and infrastructure dictate. The current access points can be migrated to other locations when new equipment is purchased.
Wireless Internet Adopter Characteristics

Arabasz and Pirani’s research (2002) found that students were the earliest adopters of wireless Internet. Most institutions that implement wireless Internet reported that students readily incorporate it into their daily activities: whether studying in the library, taking notes in class, checking e-mail or browsing web pages. Besides, wireless technology provided faculty better network to access and share information. A faculty member at the University of Pennsylvania stated, “It gives faculty more flexibility whenever they meet colleagues and students. They bring their laptops to the lab and have the information right there. They can download information and project it on a big screen; it’s helpful when lecturing in large classes” (Arabasz & Pirani, 2002, p. 45). The research also found that fewer institutions reported administrative use (Appendix D: Table 2.5), primarily because staff worked from assigned workstations and used the wired network for access. But the research found that as full-time enrollment (FTE) increased, wireless networking extended to more constituents of the academic community (Appendix D: Table 2.6).

While all sections of higher education were increasing their wireless networks, the actual percentage of students who had access to it varies by Carnegie classification (Appendix D: Table 2.6). Doctoral institutions had the highest percentage of users: 26%, while associate’s institutions had the lowest percentage of users: 4%. Arabasz and Pirani (2002, p. 42) listed several factors that could affect student access to wireless Internet at associate institutions.
1. Less common student ownership of laptops,
2. Fewer institutional computer labs or laptop checkout programs to enable student access,
3. Fewer colleges or department programs with mandatory laptop requirements,
4. Fewer opportunities to use wireless laptops in the classroom and/or on campus.

Arabasz and Pirani’s research (2002) found that users of wireless Internet were most frequently in the computer sciences, physical science, and business department as (Appendix D: Table 2.7).

*Wireless Internet to Facilitate Student Learning*

Since wireless Internet is becoming mainstream, some articles in the literature discussed wireless Internet to facilitate student learning in higher education. Arabasz and Pirani (2002) said that “students have readily incorporated wireless access into their day-to-day social and academic activities, and usage is expanding” (p. 10).

According to Boggs (2002, p. 38), an administrator at the College of Mount St Joseph said that:

The main advantages though are related to the user. They don’t have to go looking for a network port. They just turn on, log in and go. Or they can leave their machine on and just roam from place to place, connected and logged in all the time. Two of the most interesting aspects of wireless computing, coupled with a universal student computing requirement, have been the new workplaces students create and the forms of collaboration that take place. Now students can
plop down just about anywhere and do some quick homework, or several of them can gather around a single laptop and work on something together.

Drexel University was one of the few universities to have wireless Internet on the entire campus. It conducted a wireless survey (2001) to determine the characteristics of wireless users, how wireless Internet was used and whether it was used to enhance the academic experience. The survey data revealed that most students used the wireless network for a combination of personal, coursework, and job-related work. Students used wireless most for the following activities: in class to access professor’s notes; for group work or collaborative learning; to look up reference material in class; to access notes, assignments and homework in class; for controlling robots in the robotics lab; and for laptop-based experiments in the science lab.

A recent study by Lu, Ma, and Turner (2004) asked, “How are college students using wireless Internet to facilitate student-centered learning?” The researchers conducted a web survey of the student wireless Internet users at Ohio University and conducted interviews with 11 students and 2 instructors. The researchers found that wireless Internet can promote student-centered learning by providing a choice of location, more conducive learning environment, flexibility of time, easy involvement in group projects, and improved communication with instructors and other learners. However, only a handful of instructors were using it in classrooms. Some instructors were not even aware of the availability of wireless technology on campus. The researchers recommended that new teaching strategies and models need to be developed to take full advantage of wireless technology.
Wireless Internet and Student Achievement

A study by two researchers (Grace-Martin & Gay, 2001) at Cornell University found that wireless Internet programs had mixed effects on the grades of students. While ubiquitous access to the Internet could enhance a learning environment, it could also harm students' grades in some cases. They thought that this so-called ubiquitous wireless Internet might enhance student performance because laptops "extended" the school day, and students continued working on assignments after class was over.

The study logged the Web-browsing activity of about 80 students in two separate courses, a computer-science course and a communications course. A $300,000 grant from the Intel Corporation, given specifically for this study, provided laptops and wireless access for the students. Through a central server, the researchers recorded the amount of time that each student spent surfing the Web and the number of Web pages he or she visited, and then compared that to the student's grade at the end of the semester.

According to the report of the study, communications students who visited more Web sites during class scored higher than other students in the course. “There was a positive correlation between sessions per Day/Class and final grade ($r = +0.485, p = .03$)” (p. 102). In the report, the researchers pointed out that web browsing was an integral part of the course, which studied how the Internet aids communication. However, those communications students who spent more time online at home performed less well than those who spent little time online at home. “Outside of the classroom and away from the ‘structure’ of the school day on campus, there’s robust evidence that Comm 440
(communication) students’ academic performances degraded with Web browsing” (p. 102).

There were contrasts in the computer-science course as well. The more time that computer-science students spent browsing during class, the worse they performed, the report said, however, browsing times outside of class seemed to have little effect on the students' grades.

Across both courses, the research revealed that “the longer the average browsing sessions students engaged in during class, the lower the final grades they tended to receive” (p. 103). They thought that student achievement might be boosted by “limiting network access in certain contexts and forcing a focus on the content and applications” (p. 104). “Just putting them in the classroom could be a curse,” Gay said. “But if we think it through, there could be terrific benefits” (Carlson, 2001).

Wireless Internet and Teaching

Arabasz and Pirani (2002) stated that wireless networking was a “relatively inexpensive way to guarantee Internet access in any classroom, providing new locations for hands-on teaching” (p. 44). They listed some impacts of wireless Internet on classroom teaching: greater collaboration and communication, greater access to resources, changes to pedagogy, and distraction in the classroom.

1. Greater collaboration and communication.

Wireless Internet enables students to access databases on the web for in-class manipulation, brainstorm in a foreign language via chat functions, and conduct real-time research with a class topic. Besides, students can modify the environment to facilitate
their collaboration, for example, sitting together at a table or configuring their desks into a circle. One of the MBA students of the University of Tennessee explained, “We’ll all be accessing different information, talking about it at the same time so we can share information. And we flip back and forth between screens” (Arabasz & Pirani, 2002, p. 44)

2. Greater access to resources

Wireless Internet enables faculty members to present relevant online material in class while lecturing. An instructor in geology used wireless Internet to access web pages in class to look at large images of rocks and dinosaur fossils. The instructor commented, “The speed of access and the exposure to a wider variety of information and material online enhances their learning,” and “The experience is more life-like because they are not analyzing some diagrams in a book” (Arabasz & Pirani, 2002, p. 45).

More importantly, faculty members noticed that students used wireless Internet proactively to access web sites during class to enrich their knowledge of the subject under discussion. “You start to see students think differently,” explained a professor of the University of Tennessee. “You start to see them automatically think when we’re approaching a subject or a review of a concept in class, ‘Let’s go to company X’s Web Site to see how they do it’” (Arabasz & Pirani, 2002, p. 45)

3. Changes to pedagogy

Arabasz and Pirani (2002) commented that “wireless is just one aspect of the entire technological evolution impacting higher education pedagogy in general, but it can accelerate the process” (p. 45). Although it took a significant time investment to learn how to use wireless technology in the classroom, many faculty members thought the
effort was worthwhile because it enhanced the learning environment and the quality of students’ work. A director of elementary education at Middlebury College explained,

It became clear to me that I had to change, to make a huge leap forward in the way I dealt with my students. I had to accept multitasking among my students……Students were way ahead of me in terms of how to use the wireless laptop effectively. But I will never revert to the old way, because now they can accomplish twice as much in class in the same amount of time. It was an epiphany! (Arabasz & Pirani, 2002, p. 45-46)

4. Distraction in the classroom

There is another debate rising with wireless access in the classroom: inappropriate use. Some faculty members insisted that wireless Internet provided a source of diversion. One faculty member described it as “fun and sexy ways to wander during class” (Arabasz & Pirani, 2002, p. 46). Yet many believed it was a new angle to an old problem: class management. A professor of Dartmouth College explained,

Students can check their e-mail during lectures, but because they are so engaged, they tend not to…….When a class is well taught, wireless distraction is a non-issue. Wireless tends to amplify the climate of learning in that particular classroom, not change the direction (Arabasz & Pirani, 2002, p. 46).

Almost 63% of respondents of the ECAR’s online survey (Arabasz & Pirani, 2002) agreed that wireless Internet did not encourage inappropriate classroom use. One big challenge for wireless Internet, stated by Arabasz and Pirani (2002), “is for faculty to meaningfully incorporate wireless into the classroom curriculum” (p. 10). Larry Levine,
director of computing at Dartmouth College, one of the first institutions having a campus-wide network 15 years ago and one of the first campus-wide wireless networks now, reported that although students love wireless Internet, the teaching has not changed. He said,

I don’t think that it (wireless Internet) has changed how faculty teach. For the typical faculty, teaching is still lecture- or classroom-style. They may say, ‘Let’s look this up...’ but they don’t, for the most part, say, ‘Be sure to bring your laptop to class’ (Campus-wide wireless, 2002, p. 15).

He continued, “there is not a lot of live teaching use with wireless. Where the use takes place, I think, is outside the classroom as people do their work and as they communicate with each other. It frees people up” (Campus-wide wireless, 2002, p. 16).

Bhave (2002) predicted wireless Internet would be a challenge for teacher control and a revolution in learning. He said that when wireless technologies permeate classrooms in schools and colleges.

They (wireless technology) will raise issues of stewardship and control for the teacher. How can a teacher assert the necessary and traditional control over classroom proceedings to remain effective? How can a teacher retain focus and discipline in the classroom when students multitask with ease? Can the technologies be used for educational benefits, e.g., through augmenting subject matter with instant research or through greater participation? (p. 17)

Bhave thought that student and teacher behavior in wireless Internet enhanced classrooms would materially change, because there would be new options for interaction
between: students among themselves; students with their teachers; students with outsiders; and students and teachers with the Internet. And these new options would prove to be beneficial to the class at times and disadvantageous to the class at other times. He said:

As laptop use spreads among students, its use will extend outside of the classroom and into places such as bookstore cafes, lounges and homes. The technologies clearly represent an intervention in the classroom and a pedagogical challenge. Classroom etiquette may change; and learning potential may increase through healthy, intraclassroom, nondisruptive communications, as well as through the use of the Internet's timely, global resources. (p. 18)

Although wireless Internet has the potential to enhance learning, it poses challenges to teachers' classroom objectives and requires new etiquette and protocols for control. Bhave proposed some possibilities: “No laptops allowed in the room.” “Laptops allowed for taking notes, for local contents but no access to the Internet in the classroom.” “Laptops allowed, access to enterprise LAN and the Internet permitted, and with the teacher's permission, can be used to augment learning” (p. 22). Bhave suggested a technical solution to the problem of regulating access to outside content during class: “a ‘master’ computer belonging to the teacher can control the access point (AP) that is feeding the classroom” (p. 22). At different times during the class, the AP may be "opened" to various ways by the teacher. For example, sometimes the teacher may allow the students to have full access to the Internet; sometimes the teacher may allow "one-to-many" access where only the instructor can send information to the class through the AP.
The Barriers of Wireless Internet Implementation

Some articles mentioned the barriers of wireless Internet. According to Arabasz & Pirani’s (2002) study, there are problems with inappropriate student access. About one-fifth of institutions that have implemented wireless networks reported that there was a problem with students using wireless access during class/lecture time for non-pertinent content. One administrator at Florida State University said: “we see a significant exposure for abuse and misuse” (p. 61).

The ECAR Respondent Summary (2002) study revealed that security and end-user support were the most frequently faced challenges for wireless networks. The next were higher cost than expected, support for printing, and interoperability with the wired network. The research also found that although most respondents worried about security, few could outline specific incidents. The respondents from Wake Forest said: “Security has not yet been a problem. When it develops, it could be immense.” According to Project's 2002 Campus Computing Survey, the respondents across all sectors considered network security as a critical issue: score in 2002 was 6.5 on the 1 to 7 scale of importance, compared to 6.4 in 2001 and 6.2 in 1999. Additionally, the survey data suggested that network security might have improved slightly over the past year because the respondents rated their “network security against hackers and virus attacks” at 5.0 on the 1 to 7 scale from poor to excellent, compared to 4.9 in 2001.

Summary

Although wireless access to the campus network is becoming more commonplace, institutions are still at the beginning stage of adoption in education. There are many
possible applications of wireless technology for teaching and administration (Grush, 2002). Like Hammond and Salpeter (n.d.) said, “As with any use of technology in education, the key to successful implementation of wireless computing involves planning, staff development, partnerships, community-wide support and an emphasis on what is really important: empowering students to learn and grow” (p. 7).

The literature review of wireless Internet in higher education provides the context for research questions 4 and 5 in this study.

4. What teaching strategies and models are instructors developing in wireless environments?

5. How are classroom atmosphere, etiquette, and pedagogy changing in wireless environments?
CHAPTER 3: METHODOLOGY

Introduction

The research question that guided the study was: What factors influence the diffusion of wireless Internet technology among faculty members at Ohio University? To acquire this information from the faculty and staff, qualitative research methods were employed. According to Patton (2002), one advantage of qualitative methods is that they “typically produce a wealth of detailed information” and “increase the depth of understanding of the cases and situation studies” (p. 14). Denzin and Lincoln (1994) stated, “Qualitative research is multi-method in focus, involving an interpretive, naturalistic approach to its subject matter (and so) qualitative researchers deploy a wide range of interconnected methods, hoping always to get a better fix on the subject matter at hand” (p. 2).

Diffusion theory provides tools for both quantitative and qualitative research. Rogers (2003) distinguished variance research and process research. Variance research is “a type of data gathering and analysis that consists of determining the covariances (or correlations) among set of variables, but not their time order” (p. 196). Most diffusion research is variance-type research, which is conducted using quantitative research methods, such as one-shot surveys and highly structured questionnaires. While variance research is appropriate for investigating variables related to innovativeness, it cannot measure the process dimension of data and cannot “probe backward in time to understand what happened first, next, and so on” (p. 196).
In contrast, process research is “a type of data gathering and analysis that seeks to determine the sequence of a set of events over time” (Rogers, 2003, p. 196). Process research is typical qualitative research using in-depth personal interviews. The strength of qualitative research methods lies in their helpfulness for understanding the meaning and context of the phenomena studied and the particular events and processes that make up these phenomena over time, in real life natural settings. Therefore, the wireless technology study was designed as a process research to discover the technology diffusion process among faculty members and reveal the teaching strategies and models in wireless environments. Wireless Internet was such a new emerging technology that little research had focused on the diffusion process of faculty members in higher education. Thus, a qualitative research method is appropriate to discover the technology diffusion process among faculty members and understand what factors influence the diffusion process.

This study was a case study at one university. Qualitative interviews, classroom observations, and documentation analysis were the sources of data. The data collection lasted six months, from October 2004 to March 2005. The participants were 16 faculty members and seven administrators.

The researcher observed eight class sessions when the faculty were using wireless technology for class teaching. These classes were from different disciplines: linguistics, education, computer sciences, and statistics.

Besides, the researcher reviewed the documents about wireless Internet from the web sites of CNS and CITL. CNS had a web site named “Connect to Wireless Network” (http://technology.ohio.edu/wireless/), which provided information about recommended
equipment, wireless advantages and disadvantages, coverage locations, account, security and other technology support. CITL had a web site named “Ohio University Wireless Pilot Group” (http://teach.citl.ohiou.edu/wireless/), which mission was “to develop and test creative teaching strategies using wireless technology, documenting related pedagogical and ethical issues.”

The Researcher

The researcher in this study has been interested in wireless Internet technology since Fall 2002, when he started working as a graduate assistant for the PT3 grant (Preparing Tomorrow's Teachers to use Technology) for two years to assist faculty members to integrate technology into the curriculum and provide technology support. He was the wireless technology specialist for the grant in the College of Education. Meanwhile, some of his friends were setting up wireless networks in their apartments or houses. On the same time, CNS was expanding its “First Wave” wireless networking project at Ohio University.

In July 2003, the researcher with Ma and Turner was awarded a research grant from the Research Center for Educational Technology (RCET) at Kent State University to investigate how college students are using wireless Internet to facilitate learning. The research combined both qualitative and quantitative methods. The results of the RCET study, which focused primarily on students, have motivated the present study of faculty members.

In addition, the researcher had opportunities to mentor faculty members of Ohio University to integrate technology into their teaching and learning. The researcher also
participated in a Wired Professor project to mentor a faculty member on how to effectively use instructional technology in his teaching and research. From all these experiences, the researcher became motivated to study the impact of the emerging technology on higher education.

Pilot Study

A pilot study by the researcher with Ma and Turner (2004) asked, “How are college students using wireless Internet to facilitate student-centered learning?” The purpose of this research was to investigate how college students were using wireless Internet and explored the possibilities of integrating the emerging technology into the curriculum. The research questions were: How are college students using wireless Internet in the classroom and outside the classroom? From the students’ viewpoint, what are the benefits and drawbacks of wireless Internet to support student-centered learning? What innovative teaching strategies and practices are instructors developing in wireless environments to support student-centered learning? The study was conducted at Ohio University and the participants were college students and instructors. Student-centered learning theory was used as a theoretical framework. A web survey and semi-structured interviewing were the methodologies employed.

With the help of CNS, a web survey was sent to Ohio University students at the fourth week (Oct 03, 2003) of fall quarter, 2003. The survey was targeted to student wireless Internet users. Based on CNS login data, there were 899 users accessing the wireless network during October, 2003, including students, faculty and staff. There were 189 student responses at the end of fall quarter (Nov 26, 2003), among which 186 were
Many of the participants not only finished the Likert scale and demographic questions, but also wrote comments and provided contact information for interviews.

After the survey, interviews were conducted with 11 students (9 male and 2 female) and 2 instructors (one male and one female). Semi-structured interviews were employed to elicit in-depth responses. All the interviews were conducted face-to-face and tape-recorded for transcription. Each interview was based on self-report and lasted about 30 minutes.

The researchers found that the students showed consistently positive attitudes that wireless Internet could help their study and learning. Wireless Internet can promote student-centered learning by providing a choice of location, better learning environment, flexibility of time, easy involvement in group projects, and improved communication with instructors and other learners.

As shown in the pilot study, students were ready to learn in a wireless classroom, and they were enthusiastic about the potential of wireless Internet because it allowed them to be active learners where they could choose the location, time, and mode of communication for their learning. However, there were very few instructors using this technology in their classrooms. Some did not even know about it. Interviews with two instructors showed that new strategies and learning models needed to be developed for the instructors if the institution wanted more instructors to integrate wireless Internet into classrooms. The researchers recommended that the institution needed to make a long-term sustainable plan to develop wireless curricula, instructional strategies, and professional training models.
According to Glesne and Peshkin (1992), a pilot study is “to learn about your research process, interview schedule, observation techniques, and yourself” (p. 30). The pilot study conducted by the researcher at Ohio University helped the researcher identify participants, design the interview questions, identify the most convenient way to introduce the research study to the faculty members, and learn how to organize and conduct the interviews, such as time and place for interviews.

Research Participants

This study focused on faculty members at Ohio University who used wireless Internet in instruction and research. The participants were nine adopters and seven non-adopters (nine male and seven female) faculty members from six colleges of Ohio University. Thirteen of them were full-time faculty and three were part-time faculty - Teaching Assistants.

The research also interviewed seven administrators (six male and two female) from several Information Technology (IT) departments: Information and Technology Office, Communication Network Services (CNS), Center for Innovations in Technology for Learning (CITL), Center for Teaching Excellence, and Registrar's Office. Some of the administrators were also part-time instructors.

The exact number of faculty members of Ohio University who used wireless Internet was very hard to determine. CNS was expanding the wireless coverage to more and more departments and buildings. Some departments had their own wireless Internet devices, like wireless carts and access points. Furthermore, some faculty members had
wireless devices at home, and it was hard to track them down. All these reasons increased
the difficulty of identifying the population of faculty wireless adopters at Ohio University.

The researcher used multiple approaches to recruit participants:

1. From the pilot study, the researcher had identified several faculty members who
   were wireless Internet adopters. Besides, the researcher had information of
departments and programs that had wireless equipment and support faculty to use
   it.

2. The Center for Innovations in Technology for Learning hosted a seminar during
   fall quarter, 2004, which was aimed at incorporating wireless technology. The
   seminars helped faculty develop methods for using wireless tool in their teaching.
The researcher participated in these seminars as an observer, which also helped
the researcher recruit participants.

3. More faculty and administrator participants were identified through snowball
   sampling strategy. Snowball sampling is to ask interviewees to recommend
   prospective participants. The snowball sampling worked very well and lists of
   participants were obtained through recommendations of the interviewees.
   Thirteen out of a total of 23 interviewees were identified through the snowball
   sampling strategy.

Through these efforts, the researcher interviewed 23 participants (16 faculty and 7
administrators). The faculty members were 9 adopters and 7 non-adopters (9 male and 7
female), who were from 6 colleges of Ohio University. Thirteen of them were full-time
faculty and 3 were part-time faculty or teaching assistant (Appendix D: Table 3.1).
The researcher also interviewed 7 administrator staff (6 male and 2 female) from several IT departments: Information and Technology Office, Communication Network Services (CNS), Center for Innovations in Technology for Learning (CITL), and Center for Teaching Excellence. Some of the administrators were also part-time instructors.

The researcher was conscious of maintaining respect and dignity toward the research participants throughout the research study. Stake recommended that, “Qualitative researchers are guests in the private spaces of the world. Their manners should be good and their code of ethics strict” (Denzin & Lincoln, 1994, p. 244). The researcher respected the participants’ limits of accessibility and heeded the agreement regarding time allotted for the interview.

A Case Study

The methodology of a study must be appropriate to the issue the researcher is investigating. The case study can accommodate a whole range of paradigms, disciplines and philosophical perspectives (Merriam, 1988). A case study is one case or a small number of cases that examine in detail by using whatever methods are appropriate (Punch, 1998, p. 150). The general purpose of a case study is to develop a full understanding of the case. Yin (1989) described a case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used” (p. 23). In other words, case studies have advantages for research of new phenomena. The wireless Internet is an emerging technology in higher education,
and the study is to understand the diffusion process of the new technology among faculty members at Ohio University. Case study is an appropriate approach for this issue of study.

Stake (1994) recognized three main types of case studies:

- The intrinsic case study, where the study is undertaken because researchers have an “intrinsic interest” in the case or wants a better understanding of this particular case.
- The instrumental case study, where a particular case is examined to give insight into an issue, or to refine a theory. The instrument case study is an instrumental to accomplishing something rather than understanding a particular case.
- The collective case study, where the instrumental case study is extended to cover several cases, to learn more about the phenomenon, population or general condition (Punch, 1998, p. 152).

This research study is theory-guided research to understand the diffusion of the emerging wireless technology in higher education. Therefore, the study is an intrinsic case study.

The case of wireless technology among faculty members at Ohio University was a unique case with characteristics of its own and deserved research for its own sake. Besides, Ohio University might exhibit a different structure and culture that was different from other universities either supporting or inhibiting the diffusion of wireless technology among faculty members.

However, no entity could exist without connection with other entities. The unique case of one entity can have significant suggestions for other entities. From the literature
review, many universities and colleges were conducting wireless projects and the wireless technology was becoming mainstream in higher education. The case of Ohio University may suggest the similar factors that influence the diffusion process of wireless technology among faculty members at other universities. It can also inform other universities in their practice of diffusion of wireless technology into teaching and learning. Any university that is trying to adopt wireless technology into teaching and learning can interpret and understand its own case based on the suggestions of the results of this particular case study of Ohio University. The reader is the one who interprets and decides which part of the case is applicable for his or her case at hand. The beauty of case studies lies in readers’ interpretation (Stake, 1981).

Punch (1998) summarized four characteristics of case studies. First, the case has boundaries, though the boundary may not necessarily be clearly evident. The researcher needs to identify and describe the boundaries as clearly as possible. Second, the case needs a focus. It is a case of something. The researcher needs to determine the unit of analysis. Third, the researcher needs to preserve the wholeness, unity and integrity of the case. It should be a holistic study. Fourth, case studies have natural settings, and multiple sources of data and multiple data collection methods should be used in the study.

Based on the characteristics of case studies by Punch, the researcher defined the case to be the case of diffusion of wireless Internet among faculty members at Ohio University. The university, Ohio University, was the unit of study. Faculty members who adopted wireless technology were the focus of the study. The attributes and interactions of the adopters and the opinion leaders were examined through interviews and
observations. The university as a whole was examined as a social system in terms of its cultures, policies, and their relations with the diffusion of wireless technology. The study used multiple sources of data, such as interviews with faculty and administrators, observations, and analysis of policy documents.

Data Collection

Multiple data collection methods were applied in this study, which included semi-structured in-depth interviews, observations and document analysis. The researcher used semi-structured in-depth interviews to let the participants explain their experiences to adopt or not adopt wireless Internet. The researcher interviewed both faculty members who were wireless Internet adopters and non-adopters. Moreover, observations were conducted to discover the innovative teaching strategies instructors were using in wireless environments.

In addition, administrators from IT departments were interviewed, and documents related to wireless technology at Ohio University were reviewed. Taken together, these multiple sources of data are a means of triangulation (Patton, 2002).

Semi-structured In-depth Interviews

The researcher used semi-structured in-depth interviews to let the participants explain their experiences to adopt or not adopt wireless Internet.

Unlike structured interviews, which are strictly planned and controlled beforehand with every possible interview question, a semi-structured interview is conducted with a fairly open framework, where a number of interview questions are prepared in advance
based on the research questions and theoretical framework. These questions are open enough to initiate subsequent questions that cannot be predicted (Wengraf, 2001).

Contrary to common beliefs, semi-structured interviews are fully prepared and planned in advance. According to Wengraf (2001, p. 5), semi-structured interviews are even more difficult than fully structured interviews because successful semi-structured interviews require:

- As much preparation before the session
- More discipline and more creativity in the session, and certainly
- More time for analysis and interpretation after the session.

Similar to unstructured interviews, semi-structured interviews will have a written set of topics and questions. In unstructured interviews, the interviewer will guide the interviewee as little as possible, and the interviewees will form their own responses to questions and let the responses go in any direction they want. In contrast, a semi-structured interview will have an interview guide that specifies both the questions and the manner in which the questions should be asked. The guide is very important for the interviewer to collect comparable qualitative data from one interview subject to another (Bernard, 2002).

In addition, semi-structured interviewing needs to be in depth. In other words, the interview will not stop at the level of appearance, but will go deep inside the reality to see how complicated things are. In order to do so, the majority of the interview questions are formed during the interview so as to allow flexibility for both the interviewer and the interviewee to discuss details and issues. The semi-structure format provides an
opportunity to probe for what is not known for a certain issue, or gain different perspectives and a range of insights.

The open nature of semi-structured in-depth interviewing requires the interview to be conversational, two-way communication. The interviewer and the interviewee can both give and receive information during the interview. In Wengraf’s words, “the interview as a whole is a joint production, a co-production, by you and your interviewee” (Wengraf, 2001, p. 3).

Once the type of interviewing is determined, practical aspects of the interviews need to be considered. Punch (1998) clarified three aspects: the interview respondents, managing the interview, and recording. For interview respondents, Punch (1998, p.180) called attention to some major issues:

1. Who will be interviewed and why?
2. How many will be interviewed, and how many times will each person be interviewed?
3. When and for how long will each respondent be interviewed?
4. Where will each respondent be interviewed?
5. How will access to the interview situation be organized?

Rubin and Rubin (1995) suggested that the participants of the interviews should be the ones who are informants of the issues the researcher is studying. In this case study, the early wireless adopters and administrators were be the informants mostly needed.

The place of the interview should be natural, safe and comfortable for both the interviewer and the interviewee. Rubin and Rubin (1995) suggested that the setting for
the interviewee should be relaxing and the surrounding should be quiet without noises, because the recording needs a quiet background to ensure quality. In this study, most interviews were conducted in the office of interviewees, a comfortable and convenient setting for them.

The interviews were organized through telephone calls and emails so as to get the permission of interviewees about the time and place of interviews. Follow-up questions were through email or face-to-face depending on the situation.

For the issue of how to manage the interviews, Punch (1998, p. 180-181) provided a checklist of five headings:

1. Preparation for the interview - the interview schedule
2. Beginning the interview - establishing rapport
3. Communication and listening skills
4. Asking questions - the sequence and types of questions
5. Closing the interview

Three sets of interview protocols were developed for faculty adopters, faculty non-adopters and administrators, respectively (Appendix C). According to Rubin and Rubin (1995), an interview protocol ensures that the direction of the conversation is relevant to the issues concerned. Researchers need a certain control of the interview and yet at the same time should know not to control too much. The protocol questions are there, but researchers should be flexible so as to leave the questions open-ended for the interviewee to talk about their experiences in depth. For this case study, a set of protocol questions was designed based on the theories of diffusion of innovations and factors
affecting the diffusion process. Therefore, in this study, the interviews had structures around the issue of the diffusion process, communication channels, time and social system, and at the same time, the interviews were open to unexpected events because the experiences of each adopter were different and the interviews were designed to find out as much as possible about the construction and reconstruction of meanings of an adopter during the diffusion process of a technology. The protocols were reviewed and adjusted after the first several interviews in order to gain richer information in subsequent interviews. Relevant questions were emphasized and added. Irrelevant ones were reduced.

Since different participants had different responses to the questions, probing questions were asked for more details and clarification. According to Rubin and Rubin (1995), “Probes signal the interviewees that you want longer and more detailed answers, specific example, or evidence…they ask the interviewee to finish up the particular answer currently being given and they indicate that the interviewer is paying attention” (p. 148).

To start an interview, the researcher notified interviewees of the purpose of the study and shared his own experiences so as to establish rapport and stimulate the atmosphere of conversation. Interviewees would then be more open to talk about his or her experiences (Rubin & Rubin, 1995).

Communication and listening skills are crucial for the success of an interview. Interviewers need to listen carefully (Rubin & Rubin, 1995). When interviewees talk about an experience, interviewers should be sensitive to the information that is related to the understanding of the issue under research. One important skill is to find controversies
in the interview and ask follow-up questions to clarify the real meaning, and it is usually rewarding to solve the controversy. Another skill is to sense what is missing in the interviewer’s account and ask probing questions to get data. The communication skills also include the skill not to hurt the feelings of interviewees and not to endanger the situation of the interviewees in any way.

Rubin and Rubin (1995) suggested that the closing of the interview should not be a sudden stop. The researcher established a relationship with interviewees. The researcher should not make interviewees feel they are being used. Instead, the interviewer made schedules for future contact, asked follow-up questions, and asked for confirmation of the transcripts. The strategy is that the researcher should keep up the relationship because it is valuable for the researcher and interviewees.

The interviews were recorded on tape for transcription. Extra batteries and tapes were ready to avoid the unexpected situation. All the interviews were done face-to-face. All the records were kept confidential and the researcher protected the participants’ privacy by not using their names or other unique identifying characteristics in any of the reports.

**Observations**

The reason for the use of observations to collect data is that it allows the observer to see the phenomena in its natural setting and it is effectively used with other methods. Adler and Adler (1994) quoted Phillips that “the naturalness of the observer role, coupled with non-directional, makes it [observation] the least noticeably intrusive of all research
techniques” (p. 382). Two kinds of observations were employed in the study: participant observations and classroom observations.

*Participant Observations*

The researcher observed faculty members in attending a wireless seminar. The Center for Innovations in Technology for Learning (CITL) hosted a seminar aimed at incorporating wireless technology into the classroom environment. “The goal of the project is to develop creative teaching strategies using wireless technology and to help build a hybrid traditional/online classroom model”, said Kranyik and O’Donnell (2004) in an email communication with the researcher. CITL provided faculty forums to discuss pedagogical issues, technology support, and ideas. There were 24 faculty members in the seminar. The researcher attended the seminar as a participant observer, which enabled the researcher to learn faculty’s perspectives on the use of wireless Internet.

Diffusion is a social process. People have attitudes toward the innovation and they use their meaning system to make decisions to adopt or not adopt wireless technology in their own classrooms. Participant observations helped to immerse the researcher in the real life of the university so as to learn and understand people’s habits and also decipher the social structure that binds the people together (Punch, p.188).

*Classroom observations*

Classroom observations were also conducted to identify the innovative teaching strategies faculty members were using in wireless environments. With the permission of faculty members, the researcher visited classrooms to observe how faculty members used
wireless Internet in their teaching, what were the innovative teaching strategies and models, and how students responded and used the technology in classrooms.

Ethical issues are important in observations. Before each observation, the researcher introduced the purpose of the study to the instructors and told them frankly what the study was about. During the observations, the researcher took field notes about technology usage, discussions, demonstrations, and class activities.

**Triangulation of the Study**

Besides the data obtained through interviews and observations, other data sources were used to increase the qualitative validity of the study. Triangulation can strengthen a study by the use of multiple data sources or methods (Patton, 2002). The study interviewed faculty members who were wireless adopters or non-adopters. In addition, administrators from IT departments were interviewed. Besides the interviewing and observations, document analysis was used to strengthen the triangulation of the study.

**Data Analysis**

What is qualitative data analysis? Bogdan & Biklen (1998, p. 157) defined it in detail:

Data analysis is the process of systematically searching and arranging the interview transcripts, field notes, and other materials that you accumulate to increase your own understanding of them and to enable you to present what you have discovered to others. Analysis involves working with data, organizing them, breaking them into meaningful units, synthesizing them, searching for patterns,
discovering what is important and what is to be learned, and deciding what you will tell others.

Bogdan and Biklen (1998) suggested that researchers do analysis in the field and outside the field. Researchers usually enter the field with several general questions. After the entrée into the field, researchers need to assess the set of questions and try to find out which questions are more relevant than the others, and reformulate the direction of the work. Such reformulation is in fact going on throughout the field study. Data analysis in this study followed this style of examining relevance and reformulating the direction of study every two weeks. The analysis of the field notes and the interview transcripts began right after the data collection to see which chunks of ideas were more relevant than others, so as to adjust the protocol questions (Bogdan & Biklen).

After the field work, the second phase of data analysis began by coding the interviews, observations and other data. Coding is to put tags, names or labels against pieces of the data collected. In the case study of wireless Internet, the codes were knowledge of computer technology, attitudes toward wireless technology, opinion leadership, culture, change agent, implementation, confirmation, adoption rate, early adopter, teaching strategies, and teaching philosophy.

After the coding, the data with the same code were put together to get a bigger picture of the theme. The next step was to examine across categories to find connections among themes so as to see if the data could be explained by the theory of diffusion of innovations.
The last step of data analysis was to prepare the themes for the final report. The goal of data analysis was to find themes to explain the research questions and to put together a report to present to the reader in an understandable way.

Trustworthiness

The trustworthiness of a qualitative study includes the issues of credibility, validity, and transparency (Rubin & Rubin, 1995).

Validity can be ensured by multiple sources of data formats, data collection methods or multiple researchers. In this study, multiple sources of data were used. Interview transcripts, field notes, documentations, and artifacts were used to increase the validity. In order to increase the validity, the methods and framing of the study were reviewed by the professors who were doctoral committee members at Ohio University.

The transparency is based on specific context and interactive dynamics. The procedure has been described as clearly as possible. The basic procedure was to get thick descriptions of the interviewees and made detailed field notes of the participant observations and classroom observations.
CHAPTER FOUR: RESULTS

Introduction

The researcher conducted a qualitative study to investigate the diffusion of wireless Internet among faculty members at Ohio University. The research addressed the following questions:

1. How is wireless Internet technology perceived by faculty members of Ohio University, both adopters and non-adopters, in terms of relative advantage, compatibility, complexity, trialability, and observability?

2. What is the innovation-decision process of faculty members who adopt or do not adopt wireless technology?

3. What institutional factors influence the diffusion process of wireless technology among faculty members?

4. What teaching strategies and models are instructors developing in wireless environments?

5. How are classroom atmosphere, etiquette, and pedagogy changing in wireless environments?

6. What roles do administrators play at Ohio University in facilitating the diffusion of wireless technology?

The results are organized in the following order. The concept of technology cluster is introduced first, and then Rogers’ diffusion model is used to analyze perceived attributes of the wireless technology, the innovation-decision process, adopters’ characteristics and communication channels, and institutional factors. The next sections
are wireless teaching practices, classroom etiquette and changing pedagogy. The last section is the role of administrators in technology diffusion.

Wireless Technology Clusters

A technology cluster “consists of one or more distinguishable elements of technology that are perceived as being interrelated” (Rogers, 2003, p. 249). An innovation may be perceived as an interrelated package of new ideas. The adoption of one innovation may trigger the adoption of others.

When we consider the wireless technology as a cluster, it would include wireless networks and mobile computing devices, such as laptops, pocket PC, and PDA. Even though the wireless signal covers all the campus, if there is no such device, wireless Internet means nothing to faculty and students. An administrator said that wireless network is just a necessary condition but not a sufficient condition.

A3: [suppose] any faculty works in the classroom or teaches in the classroom where the wireless network is enabled. That’s great. But that’s a necessary condition but not a sufficient condition for employing that in the classroom.

Among the needs are that the students need to have computers to connect to the wireless network and there has to be an application for the classroom.

A professor from the School of EECS (Electrical Engineering & Computer Science) stated that all faculty members of his department used wireless for their own work, but no one used it for class teaching because there was no equipment for students.

F1: We all use it (for our own work), but there is no one using it for class. The reason is that there is no classroom equipped with the wireless devices. It (the
building) all is covered by wireless signal, but there is no equipment and device for students.

The professor watched the wireless technology developed and used it for several years. He was planning to use it for his class teaching.

*F1:* I haven’t used the wireless in my class yet. I am planning to. However, in order to use wireless in my class, I need to get a notebook and a wireless device for every student. I am working on that but I don’t have that yet. There is a HP call for proposals that is active right now. They will give 20 tablet PCs with wireless capability, which you can use in the classroom. I am planning to apply for that. When I am able to provide my students with the devices, I can adopt all the cool web-based applications. But right now I can’t do it and the only thing I do is to show them live demonstrations on PowerPoint slides.

To test the web-based applications for students, the instructor borrowed some laptops for his graduate class. There were five students and they used the online quiz and chatting features of BlackBoard.

In the study, the researcher interviewed faculty members who used wireless for class teaching from three colleges: College of Education, College of Communication and College of Arts and Sciences (Linguistics Department, Modern Languages Department, and OPIE). Each of the three colleges had one or two wireless carts, which contained 15 to 30 wireless laptops. These technology packages enabled instructors and students to take advantage of wireless Internet in their classroom.
Fortunately, wireless technology is becoming a standard and many new laptops have built-in wireless cards. More and more students coming to colleges have laptops with wireless capability. An administrator reported:

*A1: We noticed that the demand was increasing each year. More and more students and parents were asking about wireless pre-college. In fact it became the top question. Last year, for sure, probably the mostly common question people asked me in my orientation I gave to all students and parents was, “How do I get wireless?”*

**Perceived Attributes of Wireless Internet**

According to Rogers (2003), the perceived attributes of innovations can help in understanding the rate of diffusion. “The perceived attributes of an innovation are one important explanation of the rate of adoption of an innovation” (p. 221). Attributes of innovations include relative advantage, compatibility, complexity, trialability, and observability. The findings related to each attribute are reported in the next section.

**Relative Advantage**

Rogers (2003) defined relative advantage as “the degree to which an innovation is perceived as better than the idea it supersedes” (p. 15). In this study, relative advantage is to what extent faculty members perceive wireless technology to have a relative advantage over wired access. Relative advantage of wireless technology is expressed as a degree of economic profitability, convenience, time and effort, and incentives.
Economic Profitability

Almost all of the wireless adopters expressed that a wireless cart is great savings for the university compared to a traditional computer laboratory. A traditional computer lab is a classroom where students are provided desktop computers connected to the Internet, and the teacher is provided with an Internet-wired computer whose output is projected onto a screen. A wireless cart is a portable cart, which contains 15 to 30 wireless laptops. Professors can move the cart to any classroom and distribute wireless laptops to students.

Wireless carts can be moved to any classroom and turn it to be a computer lab, which is a saving for the university and convenient for students. An English faculty commented that:

F4: *We are a high-technology language program. We use our computer lab a lot. It’s busy. We thought the wireless cart a way of creating another lab environment that could be used when the first lab is busy. Not only that, because it would be portable, it could go in any classroom.*

Although the adopters mentioned that wireless technology infrastructure is less expensive than wired Internet infrastructure, the non-adopters were not aware of the advantage. If you want to use wireless Internet, you need a laptop with wireless capability. Therefore, from the adopter’s perspective, a wireless technology cluster may have a high initial cost. If you already have a laptop, it may be not a problem for you to add a wireless card. One faculty non-adopter was even worried about the cost associated with wireless Internet:
Faculty 15: Of course if we need to pay for that, I will not use that. I think that’s another issue. If the university would make it available to everybody, it won’t hurt a lot to try. But there are some fees there, they may need to consider. Also, even though the university would offer free access, it might have some negative effect on budget in general. Maybe it’s not good idea to try, especially in this budget tight situation… That’s my opinion on that.

Convenience

The advantage that faculty mentioned most is convenience, portability, and mobility. One faculty adopter from computer science said:

F1: I can move anywhere: take the laptop to the classroom or to the conference room and always access the Internet.

One English faculty member reported that wireless technology is more convenient than a traditional computer lab.

F4: It (wireless technology) could accommodate smaller groups of students so you won’t have to use the entire computer lab if you have a group of five or six students, which we often have. We thought first it would just be convenient for those purposes. Now I am in leaning in the direction of having no traditional computer labs and only have wireless labs because we then save on space and any room is potentially a computer lab. This is one of the many advantages of wireless.
One linguistics faculty adopter said:

*F7: The biggest advantage of it is the convenience. I can do things that I want to regardless where I am.*

Even the faculty members who did not use wireless Internet understood the convenience. One faculty from the College of Health and Human Services said:

*F15: Should be very convenient, I think. Say, some times we meet in the old buildings where we have no access to the Internet by cable. Sometimes we meet in Perks coffee shop, where of course they don’t have the tech. If we have the wireless Internet, it would be perfect.*

The mobility and convenience of wireless technology brings greater flexibility of teaching practices in class.

**Time and Effort**

Time and effort are needed for the adoption of any technology. Faculty members are always busy. They not only teach classes, but also do research and service. If a technology does not relate to their interests or research or if they do not have any profound instructional needs for it, many of them will not spend time and effort to adopt it. Although wireless technology is easy to learn and use, it takes time and effort to employ for class teaching. One faculty from the History department commented that:

*F14: They don’t want to take the time to learn how to use it because they sort of justly guard their time and they don’t want to use it on something that some of them regard as “frivolous,” not sort of a serious means to use and improve your instruction in the classroom...I am not going to take my valuable time to learn*
that sort of things. I think that’s the attitude of many of them… Older faculties are not inclined to use it. But partly it’s a perception on their part that it would be too time-consuming to learn how to use it.

A faculty of OPIE commented that:

F2: I know the University has the push for wireless and I think it’s great. Wireless technology is like anything, you mean, there are all kinds of real cool things out there. You have to decide where you can spend your time. I think that’s probably one of the big reasons that people don’t get involved because people are busy. You can barely do what you are supposed to do and try to add something on it. If it’s pretty easy to do, it’s ok. If it requires any kind of effort, I think it’s (hard), unless the university really commits to it. The big thing is time. Most people work hard. You will give something else up. What will they give up?

Incentives

Rogers (2003) emphasized that incentives can increase the degree of relative advantage of an innovation and speed up the rate of adoption. In this study, the university did not provide incentives for promoting the use of wireless Internet. However, in winter quarter, 2003, CNS hosted several demonstrations about wireless Internet in Alden Library to help students and faculty install wireless cards and troubleshoot problems. In fall quarter, 2004, CITL had a seminar to help faculty use wireless Internet in their teaching and 26 faculty members attended the seminar.

One administrator thought incentives would encourage people to use wireless Internet and he recommended discounts and a trial period:
A2: Having the computer services offer 50% discount on the (wireless) card. Have them (users) to try several months. I have never seen with my personal use any slowdown between the wireless and the wired. They are running at the same speed and there is no negative on that side. Permit the departments to have discount to get the wireless cards to put in their laptops. Getting the discounts in buying the wireless card might be the greatest incentive to help departments to go more wireless than wired.

The administrator also talked about another kind of incentive: reducing course load for professional development.

A2: I don’t see any reason why the university could not encourage professional development. Just say, if you are uncomfortable using this (wireless technology), we are going to reduce your course by one class this quarter so that you can get aboard with this and then you will be back to your normal course level... by having reduced course work, it won’t hurt them but encourage them to be more tech-savvy.

In summary, while the adopters and administrators considered that wireless Internet is cost effective, the non-adopters did not perceive the economic profitability. All faculty members mentioned that the most important advantage of wireless technology is its convenience and mobility. They felt took time and effort to employ wireless technology for class teaching. The university did not have incentive programs to promote its use so far.
Compatibility

Compatibility is another attribute that will influence an innovation’s diffusion and adoption. Rogers (2003) said that an innovation can be compatible or incompatible with sociocultural values and beliefs, previously introduced ideas or client needs for the innovation. The findings of the current study showed that compatibility is a salient factor that influenced faculty members to adopt wireless Internet.

Compatibility with Values and Beliefs

Studies have shown that instructors who believe in social constructivism and are more reflective of their own pedagogical beliefs are generally likely to implement technology into the classroom (Zhao, Pugh, Sheldon, & Byers, 2002). Social constructivism sees learning as a dynamic process in which learners construct new ideas or concepts based on their past knowledge and social and cultural environments. Social constructivism implies the notion that learners do not passively absorb information but construct it themselves (Vygotsky, 1962; 1978).

In this study, six out of nine wireless adopters mentioned that they believed in social constructivism and considered the wireless technology fits their teaching styles and beliefs. One language professor said:

F2: I don’t like to stay at the front of class to talk. That’s usually the minimum part of my class. It (wireless) fits my (teaching) style well. And I think it teaches the students along with the great information on the Internet as well as there is lot of bad (information). They have to think and construct and do a lot of problem
solving and critical thinking. When they find sources, they will have to decide. We spend a lot of time on evaluating.

An English instructor stated that the wireless technology fit her constructivist teaching style. She said:

_F4: I used to pair the students and let them work as team. Let them going through the process and trying to create something. I’m trying to do the constructivism and then they can create and construct something. When they plug it to the overhead and projector, they can present and justify their ideas._

In contrast, almost all non-adopters said that wireless is incompatible with their teaching style, which tended to be instructor-centered teaching. They did not perceive wireless Internet as an improvement to their traditional teaching methods. A non-adopter said:

_F13: I don’t use the computers a lot in the classroom. I use it lot in presenting the material, accessing the Blackboard or showing people the resources on the web. It’s kind of teacher control. I don’t do a lot of student control._

He said that he did not use technology a lot in class. _F13: I guess my class doesn’t require that amount of technology. Paper technology is sufficient to be distributed. It differs from the workshop situation. It just depends on how much material that you want them to access. It is kind of 99% or 95% of the time that the materials can be easily captured in a few handouts._
A language instructor said that the technology might not be useful in her language classes because she valued oral communication.

F 12: I don’t think it would be so good for all of our students. My course is about language. My class is more about communicating. Internet will help some way but it can’t be used as main teaching method.

Therefore, the use of technology must fit with the faculty’s teaching philosophy and style. Faculty members who got used to their teaching styles were reluctant to change. One history faculty summarized the attitudes of non-adopter colleagues about technology:

F14: (They think) I may have to give up something or some portion of the time that I now spend on lecturing in order to integrate the new technology into my teaching. And I don’t want to do that. I set up fifty minutes lectures that I give. If I would try to use the new technology, I don’t know what I would drop or what I would edit out of the lecture that I currently give.

Compatibility with Previously Introduced Ideas

Faculty members’ previous use of technology in the classroom was an important factor influencing their use of wireless Internet.

Five out of nine adopters taught courses which were related to technology. A faculty member from Computer Sciences department taught software design and development. A faculty member of OPIE taught technology for language teaching courses as well English language courses. A faculty member from department of Modern Languages, who was also the director of the Language Resource Center, taught classes in instructional technology to students and faculty. Another faculty member taught technical
courses for communication system management. Another faculty member taught courses about technologies for music educators.

Because their courses were related to technology, the adopters were generally more familiar with computer technology and used it more in class. As the professor of Computer Sciences said, all of the professors of his department used wireless technology for their own work, and some were experts in the technology and adopted it several years ago.

An English faculty member used many programs in his class. He said:

\textit{F4: We use a lot of software: everything in MS office, a number of programs just for language teaching, some programs written by ourselves here, and some commercial programs. Most of the things we are using these days are web-based. So it’s web materials, web resources and also course management system and stuff like that.}

On the other hand, most of the courses that the non-adopters taught were not relevant to technology. These courses included linguistics, history, retail merchandising, English, Chinese, and others. The non-adopters used basic programs like Word, PowerPoint, BlackBoard, and projection units. One professor talked about what programs she used:

\textit{F15: For teaching I use the Blackboard to communicate with my students: put out my notes, post announcements there. I also use some statistical software, like SAS, SPSS for my research, and also use basic software such as PowerPoint.}
A TA said what technology she used:

\textit{F10: I am not familiar with the computers. MS Word, IE, I think that's all I use.}

Therefore, faculty members’ previous knowledge and practice is an important factor influencing their use of wireless technology or not. One administrator commented that:

\textit{A2: I think it is going to be a natural progression. (Faculty will adopt wireless technology faster) If they are already using the land-based technology, wired technology in their instructions, or if the professors realize it is easier to move their own system of wireless desktop or laptop into the classroom to present whatever they are working on. Since the wireless works the same way as the wired, there is nothing really new to learn except for plugging in the card or the software, and then play and go! There isn’t much barrier to get more people to use it. The development has been very great about not having to learn the software or the hardware configuration.}

\textbf{Compatibility with Needs}

An innovation is adopted because it is perceived to meet the needs of potential adopters. Most adopters perceived the wireless technology met their mobile computing needs. One professor commented that:

\textit{F4: I think one of the things that really motivated our faculty to use it for their own purposes is that as the campus becomes wireless they can use it anywhere. So they can take their laptops home with them or to the Alden Library, down the hallway to meet with the students, to anywhere while still working with the same...}
stuff. I think that portability makes people think about the use of the technology a lot differently, because otherwise, it was always something that I keep in my office.  

Computing or thinking about technology is something I do in office and only in my office. Now it’s more part of their lives. I think for some people at some point it is bad because they can’t get away from it and it goes with you everywhere. It’s just like a cell phone, you know.

A professor from Education commented:

F3: It’s (wireless Internet is) more convenient. You don’t have to worry about putting out the lines. You don’t have to take the class to the computer lab, which takes time. If you are in a computer room, you have to plan a whole day, a whole class in it. You can spend twenty minutes of the class doing some web search online and don’t have to spend the whole class there (in the lab). It makes the file transfer easier. Also, if I want to show my students something on the web, I can show them right there.

However, because every office and classroom already has wired Internet connections, wireless Internet is adding an alternative connection. Some faculty members did not yet find a need for wireless Internet. Almost all faculty non-adopters commented that they were satisfied with the current technology and they didn’t feel a need to go wireless.

A faculty commented that:

F14: I wouldn’t know because in fact each of the classrooms in Bentley has a computer with Internet connection available. So anything I want on the web I can
bring up and also display through the video projector on the screen. A Wi-Fi connection won’t be a benefit to me in addition to what I have now. And I don’t need it in my office because I get an Internet connection there on the computer. At home I get a Road Runner on that computer. I couldn’t really tell you how I would use Wi-Fi in my teaching.

One faculty from College of Health and Human Services said:

F15: My class meets regularly in a traditional classroom. In this building we have wired Internet access and we don’t have to have wireless. Maybe for some others who want to meet somewhere else, it would be better. Otherwise, I feel the current technology is good enough for me. Wired Internet through cable is good for me.

One administrator commented that:

A2: You have faculty close to retirement who don’t like to change. It took a lot to get them to use a computer. And now their computer is wired and they may not want to go wireless.

To sum up, between the adopters and the non-adopters wireless technology was perceived differently in regard to compatibility. Adopters considered that wireless technology was compatible with their constructivist teaching philosophy, technology-related teaching subjects, and their mobile computing needs, whereas the non-adopters did not consider the wireless technology to be compatible with their instructor-centered teaching styles, non-technology related teaching subjects, and their computing needs.
Complexity

Complexity is “the degree to which an innovation is perceived as difficult to understand and use” (Rogers, 2003, p. 17). From the adopter’s perspective, wireless Internet works exactly the same way as wired (cable) Internet, and so it is not necessary to learn any new skills. Almost all the faculty reported that wireless Internet is easy to use. An instructor from the Music department said:

F5: Oh yeah. It (wireless Internet) is easy to use. I took me a while to get signed on to process everything. But automatically if I open my browser, it’ll take me to that location (OU wireless login page).

An instructor from Computer Sciences department commented:

F1: Wireless is built in the modern operating systems such as Mac OS X, XP Pro, so there are not really a whole lot of technical issues in using the wireless... If people can use a wired computer, they can use a wireless computer. There is no technical difficulty or training involved.

Although wireless Internet works the same way as wired Internet, the faculty members may need instructions to set up wireless cards or troubleshooting, particularly for those who have limited computer technology knowledge. For example, one instructor interviewed had a new laptop with wireless capability, but she did not use it because she did not know how to set up the wireless card and access the wireless network.

Trialability

Trialability is defined as “the degree to which an innovation may be experimented with on a limited basis” (Rogers, 2003, p. 16). You need a laptop with wireless capability
to have the benefits of wireless Internet. If you do not have a laptop, you may not have many opportunities to try the benefits of wireless Internet. Thus, a wireless technology cluster (the need for additional hardware) means that wireless technology has a low degree of trialability.

In this study, eight of nine adopters had his/her own laptops with wireless cards, and one could easily check out laptops and wireless cards. In contrast, six of the seven non-adopters had no laptops, which gave them less opportunity to try wireless Internet.

*Observability*

Observability is “the degree to which the results of an innovation are visible to others” (Rogers, 2003, p. 16). The wireless signal is not visible. When people use wireless laptops in library, class, or in the hallway, other people do not know whether they are accessing the Internet or just using computers. However, it has some degree of observability. Only three out of sixteen faculty members mentioned that they were aware of the technology from observing others using it. An adopter said:

*F7:* *I think it started from the time when I noticed many American students were surfing the Internet while sitting in this building. Then I was very curious and talked with friends about the new wireless cards.*

Another adopter said:

*F5:* *I actually noticed the students out in the lobby getting online.*

A non-user said:

*F10:* *(I know wireless from) my friends. I see people use it.*
Therefore, although some faculty members noticed the wireless technology from observing others, it does not have a high degree of observability.

In summary, wireless technology was perceived convenience and mobility by all the faculty members. However, wireless technology was perceived differently between the adopters and the non-adopters in these aspects. The adopters considered that wireless Internet have relative advantage over wireless Internet in economic profitability, while the non-adopters did not perceive this relative advantage. The adopters perceived that wireless technology was compatible with their teaching philosophy, teaching practices, and needs; whereas the non-adopters did not perceived the wireless technology was compatible with their teaching philosophy, teaching practices, and needs. Although wireless Internet is generally perceived as easy to use, some faculty members needed assistance to set up and troubleshoot wireless cards. For those who had no wireless laptops, wireless technology had a low degree of trialability. Wireless technology did not have a high degree of observability.

The Innovation-Decision Process

Rogers (2003) defined the innovation-decision process as “an information seeking and information processing activity in which an individual obtains information in order to gradually decrease uncertainty about the innovation” (p. 21). There are five stages of the innovation-decision process: knowledge, persuasion, decision, implementation, and confirmation.
Knowledge Stage

The knowledge stage involves knowing that an innovation exists and acquiring some understanding about how that innovation functions (Rogers, 2003). In the study, all the faculty participants, whether adopters or non-adopters, were aware of wireless Internet. However, they displayed different kinds of knowledge about wireless Internet.

Rogers (2003) said there are three types of knowledge about an innovation: awareness-knowledge, how-to knowledge, and principles-knowledge. In the study, adopters generally had comprehensive knowledge about wireless Internet. A professor from the Linguistics department said:

_F4: I am not sure I could remember (when I started to use wireless). It was a long time ago. Personally I have been using wireless for six to seven years and I have a wireless network in my own house for about that long. Pretty much as soon as the wireless technology for consumers was available I set it up in my house._

A professor from Computer Sciences said:

_F1: I am a computer scientist and this is my field. I watched it developed. I bought a wireless card for my notebook when I was a student three years ago._

On the other hand, most of the non-adopters had limited knowledge about wireless technology. For example, one non-adopter was aware of the wireless technology but said he had not tried it:

_F14: All that I know is that several buildings on campus are wired for Wi-Fi. And several commercial buildings, mainly sort of coffee shops uptown are wired. You
need a Wi-Fi card and a laptop in order to use that technology. I have never done that.

In the study there were two instructors who had not moved beyond at the knowledge stage. One TA from Linguistics department said she did not know much about wireless Internet because she did not know much about computers and did not have a computer.

F10: I don’t know too much about the computers. I don’t know how to set it up or how to use it (wireless), because I don’t have a computer now.

Another TA had a new laptop with wireless capability and she knew wireless information from a small reminder window (wireless network connection) on the laptop screen, but she did not know how to use it. She reported:

F12: I know it (wireless) but I don’t know how to use it. My laptop has the capability but I never use it. I only know I need a card to access the wireless Internet. Nobody told me about it… It’s there. You can see it from the (computer) screen. It shows on the corner of laptop screen: wireless connection. I just don’t use it. I know that we are able to use it at the library. I don’t know whether I have a wireless card built in my laptop. I am not sure.

Although the TA who had a new laptop with wireless capability saw the wireless connection reminder in the laptop screen, she did not pay much attention to the reminder. She just closed the reminder window every time when it appeared. She used cable to connect to the Internet at home or office. She said she was too busy to check the computer instructions for the wireless Internet. The researcher was very interested in the
case and went to check the laptop. It turned out that the laptop had an unusual design: it has a control button to turn the wireless connection on/off. You need to turn on the button to access wireless Internet when you start the laptop. The TA was very happy that she could use wireless Internet now and was amazed that technology can be so easy with a little help.

An administrator commented on the different knowledge levels among faculty:

A4: Well, I think you need to be specific to say how much they know about wireless. I think many faculties know a little bit about it...For example if you give a wireless-ready computer to, let’s say, 500 faculties, I think probably only 20 or 30 will know how to get on the Internet. I think many of them will think it’s just instantaneous. They don’t realize and understand you have to log on and have to connect to and understand how it works. So I think very few know it very well. You should say: how many people know this much, how many people know this much. They have different (knowledge) levels about wireless Internet.

**Persuasion Stage**

The second stage is the persuasion stage. In this stage, an individual actively seeks information about the innovation and forms a favorable or unfavorable attitude toward that innovation.

Among the faculty members interviewed, most of the adopters had formed positive attitudes toward wireless Internet. They perceived that it was compatible with their teaching philosophy, teaching practices, and mobile computing needs. They sought wireless information from different channels: conferences, journals, web sites, friends,
colleagues, and technology staff. The communication channels they used are discussed later in this chapter.

A couple of non-adopters reported that they were actively seeking information about wireless technology and has so far formed a favorable attitude toward it. One professor from the Linguistics department reported that he was interested in the wireless pilot group meeting:

F13: Yeah, I am supposed to sign up for a project but I missed the first meeting. The wireless technology I am familiar with in this building is the MacMobile, a wireless computer that couldn’t access Internet. Instead of taking people to the language lab or a computer lab, you bring the computer lab on a cart with individual laptops which are wireless and are controlled from the master.

Other non-adopters had mixed attitudes toward it. A professor from the College of Health and Human Services said:

F15: I heard it (wireless Internet) from other faculty members. They are talking about it. One day we had a staff (member) coming from CNS. He mentioned the wireless service was available on campus. Not very often, but I hear people talk about it.

And she continued to comment:

F15: (It) should be very convenient, I think. Say, sometimes we meet in the old buildings where we have no access to the Internet by cable. Sometimes we meet in Perks, the coffee shop, where of course they don’t have the tech. If we have the wireless Internet, it would be perfect. But I am afraid that the signals might not be
Sometimes maybe you will be lost. I’m afraid to trying it. Tech is good but if it’s not working... (laugh). It is still new. That’s my concern.

Decision Stage

The decision stage is the stage that “takes place when an individual engages in activities that lead to a choice to adopt or reject an innovation” (Rogers, 2003).

Through the knowledge stage and the persuasion stage, the adopters had knowledge of the wireless technology and formed positive attitudes toward it. They perceived its benefits and advantages. Therefore, it was natural for them to decide to adopt the wireless technology if the hardware was available to them.

On the contrary, most of the non-adopters remained at the persuasion stage and had a mixed attitude toward wireless technology. They were not totally convinced by the benefits of the technology. Besides, wireless technology was very new, which had just been available for two to three years on campus. Therefore, they had not reached the decision stage: they had made no decision to adopt or reject the technology.

Why did many faculty members stay at the persuasion stage and not go to the decision stage? One professor who was an adopter summarized his non-adopter colleagues’ attitudes toward technology. He thought it was an age or a generational issue.

F6: (Some faculty think) it’s just something that the younger generation uses. I know I have been teaching long enough. Some of them say “I have been teaching so long and I know how to do all this stuff. I don’t have to do these kinds of things that my students do.” Sort of like mp3 generation things. I am not going to take
my valuable time to learn that sort of thing. I think that’s the attitude of many of them...I think it is partly a matter of generational. Older faculties are not inclined to use it.

However, another professor stated that this issue was personality more than age. 

F6: It depends really on personality type. At first, I thought it always going to be the young people. But it’s not the case. We have people who started as assistant professor or TA and don’t want to touch it and only do it because they have to. And you have people who are close to retirement say, “Well, I am at the end of career, why do I have to do it?” Other people would say, “Why would I change, I have done this for thirty years? I used my blackboard and overhead. That’s all I am interested in.” Other people say, “Hey, it’s an adventure.” It’s tricky to put your finger on them, who is going to do it and who is not going to do it. It’s more personality type: are people daring enough or are they so set their ways?

Another professor commented that personal interest is a big factor.

F2: I think the big factor is interests. Personally, I like computers. And another factor is that the students respond well to it. They like it.

Implementation Stage

The next stage is the implementation stage in which an individual puts an innovation to use. The adopters decided to use the wireless technology and began to integrate it with their routine life: communication, research, and teaching.

A professor described how she used the wireless technology.
F5: I use it over at Baker Center and at the library. If I have my computer with me with the documents that I am working on for research, I’ll get online and work on it while having coffee in Baker Center.

Another instructor used it at home and office.

F7: I already use it at home. I don’t need the cable but a wireless card to get on the Internet. I think it is very convenient, because there are limited Internet cable wall jacks in my office but I can get on the Internet wherever I go.

A professor used it in classes.

F2: I don’t use the wireless all the time, but in the classes we have the wireless cart – the laptops. I bring them to class.

Rogers (2003) said that the implementation stage may continue for a long period and “eventually a point is reached at which the new idea becomes institutionalized as a regularized part of an adopter’s ongoing operations. The innovation loses its distinctive quality as the separate identity of the new idea disappears.” For many adopters, the implementation stage “may also represent the termination of the innovation-decision process” (p. 180). As commented by an administrator:

A6: Wireless is like having water. It should just be there and should not be a memorable experience.

Confirmation Stage

The confirmation stage is the stage at which an individual “seeks reinforcement for the innovation-decision already made, and may reverse this decision if exposed to conflicting messages about the innovation” (Rogers, p. 189). In this study, because the
adopters are in the middle of implementation stage, none had reached the confirmation stage.

In summary, the study provides support for Rogers’ stages in the innovation-decision process, as applied to the use of wireless Internet among faculty members. The following table lists the numbers of adopters and non-adopters reaching each stage. Two of the 16 faculty members did not go beyond the knowledge stage and five of them reached only the persuasion stage (Appendix D: Table 4.1).

Adopters’ Categories and Communication Channels

There are different categories of adopters depending on the degree to which an individual is relatively earlier in adopting an innovation than other members. Rogers (2003) classified the adopters into five categories: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, 5) laggards. Communication channels, mass media channels and interpersonal channels, play important roles in distributing innovation information among the adopters.

Rogers (2003) said that innovators are venturesome and their interest in new ideas leads them out of a local circle or of peer networks and into more cosmopolitan social relationships. Innovators are active information seekers. They have a high degree of mass media exposure, and their interpersonal networks extend over a wide area, reaching outside their local system. This is evident from the conversations from the participants.

There were four faculty participants who can be seen as innovators of wireless Internet at Ohio University. They obtained information about wireless technology from outside of the local circle. They adopted the technology before the University had the
campus-wide network. One innovator is a faculty member who teaches Linguistics and English classes. He had set up a wireless network in his house before the University had a wireless network. When answering the question “How did you know about the wireless technology?” he explained that:

   F4: I think maybe I got the information from the Syllabus, a magazine. It may have been initially from the Apple website because Apple started with Airport software pretty early. It’s either from the Apple website or the Apple user’s group. We got a lot of information from these. We rely on their innovations to fuel us for each generation.

The second innovator is a faculty member of EECS ((Electrical Engineering & Computer Science). He had used wireless Internet before he came to the University.

   F1: I am a computer scientist and this is my field. I watched it developed. I bought a wireless card for my notebook when I was a student. Wireless network was available a few years ago and I was a student three years ago.

The third innovator is a faculty member from the Department of Modern Languages. He is also the director of the Language Resource Center, where he started the first wireless project on campus. He knew about wireless technology from attending conferences and reading articles.

   F6: I got the idea because I went to two conferences. I mean I read articles that are interesting… It had just started out. The wireless cards became affordable. Apple started. At the time it was an extra hundred dollars but you could get a little iBook laptop equipped with wireless card and an Airport station. I thought
this was a good idea. We got the card for the iBook and put the station on top. We set them up in the way that they are always on as soon as you plug them in, so the teachers or instructors do not have to do much about login. You open the thing and everything goes well... It was very successful. It’s easy to bring it into classroom... We called it MacMobile. People like this. We are actually the first wireless project on campus.

The fourth innovator is a faculty member from the School of Communication Systems Management. He said he was one of the initiators who proposed the wireless network covering all the campus. He knew the wireless technology from reviewing technology reports and articles.

Although innovators launch an innovation in a social system, they may not be respected by other members at first (Rogers, 2003). For example, one innovator reported how they started the wireless project at the University.

F8: I did a couple proposals before OU had wireless infrastructure. It’s very humorous. We got the review back of the requests for funding through the office of associate provost, the officer of information technology. They were funding annual tech projects. We proposed the wireless classroom and the review committee returned (the proposals) with the comment that students will play even more games and browse the web even more than they do now. It is totally counter productive to the education process. At that time the review committee sensed this wasn’t a good idea. We thought otherwise. We thought it does. We kept at it and tried to pursue it. It turned out we actually got at where we are now through a
multi-stage process. The CNS made the decision and we participated in it. We actually brought up our own two wireless networks in this building as a test...It took some years to actually get the funding.

Whereas innovators are cosmopolites, early adopters are localities and they generally know the innovation from interpersonal channels (Rogers, 2003). Early adopters are a more integrated part of the local system than innovators. There were five faculty members who could be seen as early adopters in this study. They obtained the wireless technology information from their peers, friends, or students. One English professor said:

F2: I found out about the (wireless) cart from XX (one colleague) and from the announcement in the building. We have the cart available... We talked lot about the ways to use it, things that have been successful, and things that have happened. Of course we talked about trouble shooting. It’s important to know how to trouble shoot.

Another professor from the College of Education said:

F3: One of my faculty members, XX, went to our meeting and introduced it, telling us there are wireless carts available for us to borrow.

Another professor from the Music department knew the technology from students and a colleague.

F5: I actually noticed the students out in the lobby getting online. The librarian here, XX, let us know there are wireless (access points) in the library.

A TA knew the wireless information from students and friends.
F7: I can’t remember it exactly. I think it started from the time when I noticed many American students were surfing the Internet while sitting in this building. Then I was very curious and talked with friends about the new wireless cards.

Non-adopters also learned about the wireless information from friends and colleagues. When one TA answered the question, “How did you know the information about wireless technology,” she said:

F10: My friends. I see people use it (wireless Internet).

Another TA knew the wireless from the wireless network reminder window on her laptop screen (refer to page 24). One Linguistics professor and one English professor knew the information from their colleagues and the technology staff. There was a wireless cart in their building, called MacMobile. The technology staff offered a workshop to learn how to use the wireless cart.

One History professor knew the technology from friends and web.

F14: From friends. When a new technology appears, I will go to the web and do a search on it so that I can understand what it is, like maybe a tech glossary that gives me a term.

One professor in the College of Health and Human Services knew the technology from her colleagues and technology staff.

F15: I heard that from other faculty members. They are talking about that. One day we had a staff (member) coming from CNS. He mentioned the wireless service was available on campus. I am not very sure. Not very often, but I heard people talked about it.
In summary, the wireless innovators obtained the information most often from mass media channels: journals, articles, and conferences. The early adopters and non-adopters were likely to know the information from interpersonal channels: colleagues, friends, technology staff and students.

Institutional Factors

This section answers the third research question: “What institutional factors influence the diffusion process of wireless Internet among faculty members?” The innovation took place in an institutional context. Rogers said, “Organizations are the ground on which innovations are scattered” (p. 402). Institutional factors can be categorized as related to the technological infrastructure or to the human infrastructure.

Technological Infrastructure

Technological infrastructure includes facilities, network, and equipment. Ely (1999) said, “This condition refers to the things that are required to make implementation work. It includes hardware, software, publications, audiovisual media, and other teaching materials” (p. 24).

Even though the wireless networks cover all the buildings on campus, you need a wireless card and a mobile computer device. Three departments (buildings) had wireless carts, ranging from 10 to 30 wireless laptops on a cart, which instructors could bring to the classrooms. According to the director of the Curriculum and Technology Center in the College of Education, there were seven faculty members who had used it for teaching.

During the interviews and observations, many faculty members mentioned that the wireless signal was too weak in some places, even in the buildings that were marked
to have full coverage. One professor showed me the problem at her office. She said her computer worked at one corner and did not work at another corner because the signals were weak. She said the signal was also weak in some classrooms.

*F3: Sometimes the students complained that they could not get online like other students. They can change to another computer. Then I have them move to another corner. Moving around would help.*

Another professor was afraid to use wireless Internet because of an access problem. He logged in to the university wireless network in class and showed students some web sites. If he left the computer for a while, the wireless Internet would disconnect and he had to log in again, which would break his teaching pace. Therefore, he always brought an Ethernet cable with him instead of accessing the wireless network.

A couple of professors were concerned with the security of wireless network. One professor said:

*F1: I guess coverage and security are the factors. All my computers are behind the firewall. But when I go on the wireless I know I no longer have the protection of my firewall... we want someone to watch for the intruders. The security is important to us.*

The advantage of using a wireless cart is mobility and flexibility. However, if there are too many laptops in one cart, like 30, the cart may be too heavy and not easy to move around to another floor or building. A faculty member in Education commented that:
F3: I found the hardest part is pushing the cart (to the classroom). If you are not teaching in this building you can’t have it... This quarter I am teaching in Jefferson Hall (another building) and I feel like I miss it a lot.

Human Infrastructure

Human infrastructure means the organizational arrangements to support technology integration. It includes support staff, policies and procedures.

When an adopter answered the question, “What kind of support do you need?” she said:

F2: The big one could be that you have to teach people how to use it (wireless technology) and you have to teach people what to do when there is a problem, which I think is one of the biggest problems with the computer itself. People always talk about how great it is, how motivating it is, and how to use it. Nobody tells how to fix a problem: what do you do when the computer freezes or it doesn’t work. There are lots of possible things that could be wrong and you have to want to at least give people some kind of plans that they can try troubleshooting on their own. It could be a lot of training.

An administrator commented that a support system must be in place to help faculty use technology. She thought that the low IT support staff ratio was a big problem for faculty technology use.

A7: (It) is unfair to ask faculty to increase using technology without having the support system that goes around them. Our ratio of faculty/staff/students to IT support personnel is not good. Our ratio is 91 to 1. Other big research
institutions, such as Indiana University, University of North Carolina, the ones we state that we want to be like, their ratio is like 40 to 1. So, we are way off scale. That’s one reason why faculty don’t like to use technology because they can’t get the help they need when they need it.

The administrator also commented that there was a special institutional culture in higher education compared to technology use in a business setting. Academics tend to be skeptical of the use of technology because of their independent nature.

A7: I worked in both business and higher education and K-12. In a business setting, you don’t have much choice about what you do. If technology is available to you by the company, there is an expectation there – you will use the technology. So, there is no debate about it. You don’t sit there and say, “Well, I just really don’t think I want to use Oracle Calendar, or others. There’s also the whole culture. Everybody else in the business is using the technology, and another huge thing is that there is much better support in the business world for people who are using technology. I mean, in (the business where I worked), we had a full staff, hundreds and hundreds of people on our tech support staff. When you had a problem, all you had to do was call the number, and they responded immediately...You know that in higher education this is not the case. There people have a lot of choices, particular faculty, because of academic freedom, what they do in their classroom and what they don’t do in their classroom. Nobody’s saying, “You will use this technology because we’ve input a lot of money on it”... I mean, using technology for teaching is a risky business, you know, the staff is not
working all the time. And because we don’t have adequate support, we put a lot to bear on faculty. You know, they have to go and get a wireless cart and roll it down to the classroom.

In sum, interviewers reports both technological infrastructure and human infrastructure issues influencing the diffusion of wireless technology among faculty members. The faculty members need mobile computer devices to access the wireless network. Although wireless networks cover most of the campus, the wireless signal is too weak in some classrooms and offices.

Wireless Internet Teaching Practices

This section answers the fourth research question: “What teaching strategies and models are instructors developing in wireless environments?”

There were two levels of adoption of wireless technology among the faculty members: for personal use only or for both personal use and class teaching. There were seven professors who reported using wireless Internet for class teaching: three from the College of Arts and Sciences, two from the College of Education, one from the College of Communication, and one from the College of Engineering and Technology. The courses they taught included: linguistics, English, instructional technology, principles of curriculum, statistics, communication systems, and software engineering.

There were two instructors who used wireless technology for personal use only. One was a professor from the Music Department, where there were no wireless laptops or wireless carts available for students in class. The other instructor was a Teaching Assistant from the Linguistics Department, who taught only for one year at the university.
The researcher also observed eight class sessions in which the faculty were using wireless technology for class teaching. These classes were from different disciplines: linguistics, education, computer sciences, and statistics.

Their teaching strategies and practices are organized in the following categories: collaborative learning, contextual learning, flexible teaching practices, posting instructional material online, accessing online relevant sources or databases, speeding up learning acquisition, and on-going assessment and instant feedback.

**Collaborative Learning**

From the interviews, the professors commented that wireless technology greatly facilitates team projects and collaborative learning. With the portability and mobility of wireless technology, faculty and students can keep up with the group whether in the classroom or out of the classroom. An English professor talked about how she used wireless laptops in class.

*F2: I also get students together in groups and revise the paragraphs and the papers. I teach them online resources they can use while they revise it. Usually when I use wireless in class, I’d like them to work with people.*

She explained that students could learn from each other in teams.

*F2: If they only work on their own, there might be something that you can just do at home. And there is no reason for them to take the class time because you don’t have much class time. A lot of students are not questioning their writing and thoughts like they should. Given enough time, they have somebody to talk to and*
work out together in that they could think about something maybe they didn’t think about before.

She explained how wireless technology could fit into students’ collaborative team projects: let students easily form teams, allow students to work in different places, and enable faculty to move around working with students.

F2: What we want to do is that we want to have computers set up so that each team has its own computer, because class frequently breaks up in to teams, and the teams during the class time work on their projects that are usually Internet-based. They usually spread around so that they can take their computer and go working in different places. And faculty can go around working with them.

One education professor also used wireless laptops for team projects in her classes. She reported students liked to share information in groups.

F3: I remembered sending my students online when we were talking about legal issues in education, like laws, and government issues. I assigned them online and they looked for some cases. We found some really interesting articles and cases there. They passed it around. That is something they like.

One professor from the College of Communication said:

F8: In some way it’s good for group work because you have the flexibility. People can arrange their physical space. They can move around in the different parts of the classroom. On a good day, they can go out to the Green to do their work… I have taken a great advantage of that…I haven’t run into any problems in most of my work.
Contextual Learning

If learning tasks are situated in meaningful real-world tasks or a problem-based learning environment, it will improve students’ understanding and knowledge transfer to new situations. Wireless technology can create a contextual learning environment. For example, an English professor used web concordancers in class.

*F2:* It (concordancer) is when you put in a word and then you decide what corpora or what body of work you want to understand around the defined. So the computer search has big collections of data of text, and it searches for every single time it sees that word and then you can see how that word is used in the sentences or, sometimes, in the paragraphs... It’s good to learn how words are used. Especially tricky words like “in fact.” It might be hard for me to explain and you might be able to go a concordancer search and see all the different instances of “in fact” on your own and try to build a model how to use it.

Students learn to manage and coordinate the use of multiple resources: students learn when they can create and link together multiple representations: seeing an idea from a variety of viewpoints helps develop deep and rich understanding. One professor expressed this viewpoint:

*F2:* I think it teaches the students that along with the great information on the Internet as well as there is lot of bad (information). They have to think and construct and do a lot of problem solving and critical thinking. When they find sources, they will have to decide. We spend a lot of time on evaluating.
Flexible Teaching Practices

Wireless Internet makes teaching more flexible. Professors can use it to fit in different course subjects, have better time arrangements, and smoothly switch between projects. Students can do research in class, on-site data collection and essay writing.

Most of the professors mentioned the flexible teaching practices in this study. The director of Language Resource Center said language instructors used wireless technology in all levels of language classes to support all kinds of class activities. For example,

**F6:** Language teachers do this as a fun activity: browse the Internet, look at the authentic materials, illustrations, and go to a Spanish website and look for art and literature materials, take a virtual tour. I noticed some people who teach grammar and composition would do group exercises and peer review... You are able to do a quick web browsing activity. With ten people around you say, “Let’s pretend we are in Berlin on a study trip, find a hotel and find out what’s playing in the theatre tonight.”... So, it’s all over the place, depending on the creativity of the teacher.

The professor thought that the wireless cart was a good package for students and the use of it was very successful in the department. Many faculty members began to use it in classroom.

An education professor said:

**F3:** It makes hands-on learning and cooperative learning easier because you can actually have students do some hands-on projects instead of lecturing all the time,
and you can spend time having students do more research right in the class. In the past you had to take your students to the computer lab. You know if it is a small project, you don't want to do that. Now you have the equipment, you can do it. You can do big or small projects, 10 or 5 minutes, in class groups. It really enriches your class.

The professors mentioned that wireless carts have advantages over traditional computer labs because wireless carts are easier to fit into different class activities. A linguistics professor explained that:

F4: It's often more convenient for us to bring in a wireless lab if we are going to spend 15 minutes of class doing something on the computers instead of the whole class, because then we take out the computers and open them up and we spend our 15 minutes and we close them and put them away. If we are in the computer lab, there is this kind of focus on the computers throughout the whole class. And we think what about the computers over there while we are only using the computers for a small portion of the class.

A communication professor commented on the benefits of using a wireless cart.

F8: That model (traditional labs) doesn't work very well because in most of our classes we don't want the computers in front of the students 100% of the time. Most of these classes, out of the 45 meetings or so, we probably use the laptops less than a half or a third at a time. You bring them out when they shift in learning... In general, it is the flexibility about where I use the laptops and if I have a lab or not. With the wired network, you couldn't take the laptops out and
start stringing the wire to the room. Technically it’s not feasible. So, the wireless really makes it possible in an on-demand fashion to use them in more than one location, which for us really means either the classroom or in this room. In one class I actually teach the wireless tech with students taking laptops out to the Green. We went to that spot and measured the signal strength... So it gives the location flexibility because the wireless. We also have spare batteries so we can keep them away from their recharging station for extended period of time. That’s necessary.

A professor described how one of his students used the wireless technology in a creative way.

F4: There are so many possibilities but one story I think is really exciting. About two years ago I was teaching a group of teachers from South Africa on educational technology. One of the things we did was look at the use of wireless. One of the teachers went home and actually got a grant and purchased one of the wireless labs. Now she is a resource person who is located in a big city but she goes out to small villages everyday, where they have no electricity. She’s going into the city and charging up a set of wireless laptops that she brings to schools and villages with no electricity. And those students are learning how to use computers. They are also using the Internet because they have cell phones and modems.

In a word, the wireless technology can fit in many courses and different class activities.
Posting Instructional Materials online

Another way that faculty used wireless Technology was to post their notes and data on the web. These ranged from PowerPoint presentations to Word documents to HTML pages. Students downloaded and printed the notes, and added additional notes during lecture.

One statistics professor had posted instructional materials of his courses online, including syllabus, reading articles, assignments, class handouts, data files and outputs, statistics software, and hyperlinks to relevant materials. With wireless laptops, he could let students download the software and data, and run statistical analyses in class. If students did not follow the procedures or had unexpected outputs, he could quickly go to help them.

From the class session observations, with wireless technology, professors could transfer content and lecture notes to students immediately, so students did not have to take notes, allowing them to concentrate on the lecture. The students could also make and save their notes in class. The students could review the content after class. From a teacher’s perspective, it was easy to distribute instructional materials, such as web resources, templates, and assignments. The electronic flow of documents became an engaging factor in the classroom.

Accessing Online Relevant Sources or Database

The Internet gives students direct access to a huge library of information and sources. Wireless technology allows students to access electronic textbooks, instructional materials, and scholarly articles.
A professor in the College of Communication used many online sources in his class. From his course web site, there were links to e-books, links to relevant articles, and links to organizational web sites.

*F8:* There is an issue of what I can gain by having Internet access during class. I think the answer to that is that, especially in the class I teach, the advanced technology classes, we talked about things that haven’t made it in text books for years. They (students) never need a printed form but use online-based resources. So, having Internet access in the classroom allows my class to have a first-hand primary source access to the documents I would either have to print extra handouts or have them to read after class. The students could look at the documents right there.

One English professor described how she used online sources and a dictionary for her writing class:

*F2:* For instance, the class is having a hard time in finding the right vocabulary. Maybe they (students) use non-academic words. I’ll show them the different places that you can go online and get help to find the right words. For instance, one thing I did in the last quarter was that I pulled a word “get” from students’ paper. “Get” is informal but really common. It’s hardly known how to replace it. You can say “get” and you also say something different, depending on the content. So I had a big list of sentences that students wrote with “get,” and I showed them some online resources and a dictionary, and they worked in pairs and came up with alternative words to take out the “get.”
The professor used web “concordancers” for teaching. A web concordancer is a computer program that automatically constructs a concordance online. She found web concordancers were very useful for language teaching.

*F2: I think it (web concordancer) expands the resources. Of course you can have dictionaries in class. But having the online resources, you can have things fast. It’s fast and easy to use. You have the online concordancers. Most students really like this.*

**Speeding up Learning Acquisition**

Wireless technology enables students to have more opportunities to do hands-on practice and projects, which will speed up students’ learning process. The communication professor explained:

*F8: Having the students have the computers in front of them, I can have them use tools like Excel, for example. They can practice computational skills, as I can watch and help them through the problems. The Internet access there is really nice to have. I can give them starting points. For example, I tell them to go to our website and download that software from the computer in front of you and then start working with it. The fact that I can watch them make mistakes and correct them on the site probably shortens the learning cycle from 3-4 weeks to maybe a week or a week and a half...They usually master those skills a lot faster. They can speed up the skill acquisition because I can watch them do it*
On-going Assessment and Instant Feedback

With wireless technology, on-going assessment and instant feedback are possible. Professors can walk around the classroom and see how students are solving problems and accomplishing their tasks. Software tools are available that allow quick development of online quizzes or short surveys.

A professor of Computer Sciences department used BlackBoard online quiz function in his class. Using BlackBoard tracking system, the professor could observe an individual student’s status unobtrusively, how many average minutes the students spent on each question, and what percentage of correct answers. Understanding the progress of students during class can help a professor to manage a class. The professor can monitor his students’ activities and thus feel more comfortable about their use of technology.

F1: One of the things I always wanted to do is to use the quiz feature of BlackBoard. We do some activities in class but right now with 40 students it takes me time to work in the classroom: check what they haven’t done and see what mistakes they make. On Blackboard, there is actually a quiz system that allows multiple-choice questions. If I can get the answers, then I can know right away how students do on the quiz. And the students would know the result right away too. In this way, it would be much more effective and efficient.

From class observations, professors could readily provide invaluable and timely feedback to students concerning their projects by using wireless technology. Instant feedback was a major advantage enjoyed by a laptop required course over a traditional course. From BlackBoard tracking data, the professor could spend more time on the high
percentage incorrect questions and the most difficult questions. The professor could demonstrate in real-time how to develop particularly difficult sections. The professor could go around the classroom pointing out specific problems students might have, problems that would otherwise have taken the students hours to figure out after class.

Feedback also worked in the other direction. Students could get the results of their quiz instantly. Programs could be submitted for automatic compilation and execution. The students could follow the professor’s instructions on their laptops.

Therefore, these professors developed curriculum and methods of using wireless laptops as a pedagogical tool. They understood that wireless technology could be used as a means to increase the quantity and quality of exchanges both between themselves and their students and among students. They encouraged their students to collaborate on data collection, hands-on experiments and team work. They began to leave behind the “sage on the stage” to become the “guide by the side.”

Classroom Atmosphere, Etiquette, and Changing Pedagogy

This section answers the fifth research question, “How are classroom atmosphere, etiquette, and pedagogy changing in wireless environments?”

Laptop Etiquette

A collection of strategies for successfully using wireless laptops in class emerged from the interviews with the professors and from classroom observations. These include:

- The laptop volume control should be set to mute or off if you do not need sound.
- The laptop batteries should be fully charged before class.
- The instructor should be able to quickly exchange a laptop when it is not working.
As commented by a professor,

*F2: We have enough laptops. If the one is not working, usually you can pull out another one.*

- Move to another corner if the wireless signal is weak.
- It is better to set laptops in sleep mode to avoid long boot up times.
- Don’t drink or eat when using laptops.
- Warn students to be careful not to drop the laptops.

The director of Language Resource Center commented on laptop etiquette.

*F6: Other problems…Not that many, you know. Don’t drink, eat, or pour anything on your laptop. There is a certain etiquette you want to keep an eye on. Don’t drop the laptop and be careful. Plug the batteries in so that the next person who actually picks up the cart has to recharge the battery. This is something that could happen. You get a laptop that is just at the brink that you are unable to shut it off. As the students return the laptop, you should make sure that it is actually plugged in. There is so much preventive stuff you can do.*

*Classroom Distractions with Wireless Technology*

The literature review revealed a debate about the use of wireless technology in the classroom: distraction or inappropriate use. In this study, most of the seven professors who used wireless laptops in class did not consider class distraction a problem. The real issue they reported was to make class interesting and engage students in class projects. An English faculty commented on that:
F2: I think it is kind of silly to think the students are always listening to you. I mean, let’s say, you have no computers and everyone’s book is closed and the teacher is standing up there talking, it doesn’t mean the students are listening. How many students are listening, maybe five percent? Are they really listening? (Some) never listen. So even if they are not physically looking at something, they are not listening. I think it’s way easy (when using computers) because you can tell they’re looking at the computers. We don’t have a big class here. I try to give people the benefit of the doubt and try not to insult them.

She talked about some strategies to manage a wireless class:

F2: You know you have tricks, right? You have to give them directions before you pass computers to them (students). Make sure you write things on the board and give all your directions first. As soon as you pass out the computers to them, you know they are not going to pay any more attention to you. And then if you have something else to say, you frequently tell them to turn the computer around or shut it down. Or I just start to talk. But if there is a problem, I say, “OK, I know, email and enjoy something exciting and close your computer.” Sometimes they will look at the email. I don’t think it is a big deal. It’s not any reason to stop using it (wireless). Sometime they will do some things you don’t want them to do. But if you make the lesson interesting enough, you hope they won’t do it.

Another professor said that the wireless lab was much easier to manage than the traditional computer lab.
F4: I think the management of the wireless lab is easier in many ways. I know some teachers have problems with students paying attention to the class because they are distracted by the computers: checking their email, surfing the web, and something like that. With the class built on laptops, all you have to do is to say “close your laptop.” I mean, there is no question; you close (the laptop). They are no longer capable of doing anything. I know there are techniques for that in traditional lab but that’s not that simple. (With a wireless lab), that’s very simple. Another professor pointed out that distraction was a classroom management issue. He recommended preparing a list of links to give students direction, which will enable students to overcome distraction.

F6: If people think it’s a distraction, well, they are not good classroom managers. You have to make sure that people in the back are not doing chatting. You can do this by coming up with exercises to integrate it, I am not going to say, “Let’s browse the Internet.” You can prepare something on the web already listed in links. You say, “Yeah, go here, do this, find this. Go there, do this. Give them instruction.” So people are busy on tasks. Instead of saying, “Well, let’s do something about Spanish painting.” They all go and type “Spanish painting” into Google. Who knows what they end up with? It’s up to you to pre-select something and send people down this road.

Therefore, wireless technology was not perceived as a distraction in the classroom. Faculty member developed teaching strategies to manage a wireless class.
The Role of Administrators

This section answers the sixth research question, “What roles do administrators play at Ohio University in facilitating the diffusion of wireless Internet?”

There were two IT departments involved in the wireless technology project at the University. One was CNS (Communication Network Services), and the other was CITL (Center for Innovations in Technology for Learning). CNS is a central IT department for networking on campus, responsible for the entire wireless technology infrastructure. An administrator of CNS talked about their roles in the wireless project:

A1: Our main design concern is to make sure it works well so that people will have the flexibility to use it for whatever they come up with. There needs to be enough capacity for professors to distribute multiple media files during the class to a bunch of wireless laptops without waiting for the class to download. There needs to be an easy way get people on the network. So we got it set up to where they can get on just by a working ID. We need to make sure the coverage is seamless and supports as many machines as possible because we don’t know what kind of computers the students or faculty are going to have... Our job is kind of like providing a classroom. The Internet is becoming a part of the teaching world these days so we need to make sure Internet works well for people.

The administrator summarized their responsibility.

A1: We are responsible to install wireless on campus and promote the uses, and my major responsible is obviously to promote the use of it and to let people know
it’s there. We want to get the system out where people could use it. When people see it, hopefully they would be on board with our project.

The technology administrator thought that the wireless technology was a great financial saving for the university. CNS reported that wireless Internet was much less expensive than wired Internet when installing in old buildings which had no Internet connections (Wireless Future, 2004). For example, it cost CNS about $12,000 to install wireless Internet at Wolf apartments, which was 40% of the price of installing wired Internet. In the same report, CNS estimated that it would cost each student per academic month $4.54 to have wireless saturation on the Athens campus. However, the wireless service is provided free to the students, faculty and staff.

Wireless Internet is also cost effective for outdoor coverage. The administrator of CNS said:

A1: Our actual first wireless access point we brought up was in the summer that year and was on the College Green front door. We took that as just a very simple way to test the basic technology because outdoor coverage was very simple from our standard point in that you don’t have big issues with how to get your signal around like in the library with all the book stacks. You don’t worry about the coverage, and a single access point can cover a huge field.

CNS used the following communication strategies to promote the wireless technology:

A1: Early on we talked directly with the departments, usually with their technology representatives or a faculty member who was very aggressive to
implement this. In the early stages it was pretty much easy to find people who already wanted to do it and invite them to work with us. Now the project is taking off and becoming very common. We communicated with different department heads, technology representatives or technicians who do the work with them. We make sure to communicate directly with them. I sent email announcements about this. I found email announcements are really effective. I am also getting on the agenda for faculty meetings on campus to talk about our service. There is also another central IT department, CITL, who has put together a wireless classroom project. I think there are about 20 faculty members enrolled. So there are quite a few different avenues we are trying to follow, to see what we can do.

In addition, CNS offered several wireless network demonstrations in the fall quarter 2003. The researcher went to the demonstrations for observation. There were about 20 participants for each demonstration, including faculty, staff and students. Some elder faculty and staff were also interested in the technology. Most of them were laptops owners. They brought their laptops for testing or to purchase wireless cards.

CNS also placed posters on the walls in the buildings which have wireless coverage. The poster has a picture of a laptop with a wireless card and signal, and says, “This building has full coverage wireless Internet.” Then it lists contact information and the university’s web site about wireless information.

CNS did not provide incentives for the use of the technology. When asked whether they provided any incentive to attract wireless users, the administrator said:
A1: Not currently, not for us. I don’t know if the CITL is doing any kind of the incentives. Our impression is the rising demand is there, especially on the students’ side and probably the faculty would respond to that, and I noticed the younger faculties were already very into using it. They use it for their own lives. We have been mostly taking the approach of building a good network and people will know about it.

As for the support that faculty need for the wireless technology, the administrator commented that:

A1: I think they need easy access to technical support in case something goes wrong, such as 30 minutes before class and they can’t figure out how to get on…I would think the less-computer-savvy faculty members or the older faculty members who didn’t catch up or grow up with this technology need more training or instructional support.

He realized that faculty members who had different levels of technology skills needed different kinds of support:

A1: It depends on the level of understanding the person already has. For some people, they may just have general education of how to use Internet technologies. Their experience with computers maybe is as far as pushing the power button. Those folks are going to need education with technology in general. Then you got people who already use computers in their daily work but don’t really think of them as part of the classroom. We need to show those folks the new opportunities. They are probably at the theoretical level, for pedagogy and methodology. For
the folks who are on the high end of the skills, we don’t need to do too much for
them. They already decide they want to use.

A wireless adopter expressed the need for instructional pedagogy support in
addition to technology access.

F1: Well, they (the administrators) are working to cover more areas of the
campus, which is nice. They are managing the network. For example, when we
log in to the wireless (network), we need to sign in the log-in page first, which is
good too. But for the adoption of this technology in the classroom, I think the
main factor is the availability of the equipment. At this point I don’t see that I will
need lots of support and help from them, although once I adopt the wireless
Internet in class and many in-class activities happen based on web application,
then I will definitely see some new issues arising. CITL and the Center for
Teaching Excellence would be the perfect resource for us to go to. With this new
teaching style, is there something better we should learn or is there trouble we
should avoid? They should be the right people to do this.

In sum, CNS, the technology support department, hopes that the faculty will come
to use the wireless technology if they build the infrastructure. However, this approach
may work for the innovators and the early adopters; it may not attract the mainstream
faculty members. One administrator of CITL expressed the same point.

A7: We are certainly not the campus that has wide-spread use of any kind of
technology for teaching and learning. We are not in that kind of that status. If you
think of the diffusion curve, we have some early adopters and innovators. We
have not got to the mainstream faculty. In order to encourage more faculty to take advantage of wireless technology, you know from Rogers’ theory, we have to do much more marketing and communication. You have to give faculty some concrete examples and different types of things you can do with wireless technology. And most important, you need to convince and show faculty that using the technology is going to help them to do things, help their students learn, save them time. (You need to) convince someone that there are some benefits coming with it.

CITL was established as part of an institutional effort for designing educational technology-supported learning environments. CITL hosted a wireless pilot group to incorporate wireless technology into classroom environments. The goal of the project was “to develop and test creative teaching strategies using wireless technology, documenting related pedagogical and ethical issues” (Ohio University Wireless Pilot Group, n.d.). There were 26 faculty members from different colleges and departments who participated. One administrator of CITL talked about CITL’s roles in the wireless project:

A3: Our role is to document what they (the faculty adopters) are doing so that we could identify the strategies and share the strategies with other instructors. To let the faculty see how I can use wireless in my classroom.

Another administrator of CITL realized that most of the faculty members were not fully aware of the technology.

A7: I think students understand and know how to use wireless technology. I am not so sure faculty are fully aware of it or know whether it is available to them.
That’s one hurdle to overcome. I also don’t think most faculty have any source or have any mental image and vision about what they might want to do with wireless technology.

At least one faculty member thought most training was not effective. The professor said:

F4: I think training is probably the most important thing for any sort of integration of instructional technology. I think it’s the most overlooked and neglected area. Unfortunately most training that takes place is not very effective. I think when it’s done, it tends to only address people who are already interested.

Even then, the people who tend to be in charge of the training are far too technically adept and with not enough knowledge of pedagogy. It’s done in an informal ad hoc basis one-hour or two-hour workshop one at a time when they deal with one issue. I think really they need more integration of this sort of training in graduate programs, preparing people to become teachers, because that’s the only way you can deal with this sort of thing in a holistic manner.

Unfortunately, at the university level most people don’t go through programs of this nature, so they don’t learn anything about pedagogy.

He continued to talk about what kind of training faculty needed.

F4: The most effective way would be integrated into a teacher preparation program, so it’s all inclusive. So it deals with all aspects of integrating technology: about decision making, about how to identify and evaluate software, about how to create materials, how to learn from other people’s experiences, so
you learn a little bit of the background and some theories and research about instructional technology. I think most of these ad hoc things tend to just teach people “this is how you do this;” it’s hands-on. “This is how you make a website” or “this is how you use Blackboard.” They don’t talk about why: why you need Blackboard, or the ways that using Blackboard has been effective or not effective, things like that.

An administrator at CITL talked about how to address this problem.

*A7: We are going to change our role slightly... We are going to search interesting instructional problems that need to be solved. Hopefully, the interesting instructional problems will impact on large numbers of students. CITL needs to show we are making a difference for the support unit here. We have to show the services we provide are valuable and valued by the community. Otherwise, there is no reason to have CITL. What we’ve done is like Rogers’ early adopter approach. We sit here and wait until faculty come to us with an interesting idea, which is great. There is nothing wrong with that. But at the end of the day, if it relies on an individual faculty member to drive that agenda, you don’t get any percentage or critical mass out of it because it will end with the impact on that individual faculty member. We don’t even ask how many students are going to be influenced. In some cases, we help some projects with very small class sizes. Again, there is nothing wrong with that... We need to be able to show that we can make a difference and outcome that the University cares about... That’s what my vision of the role of CITL is in the future.*
Conclusion

In conclusion, this study used Rogers’ diffusion theory to examine the wireless technology diffusion process among faculty members, including perceived attributes, the innovation-decision process, communication channels, and institutional factors. There were differences between adopters and non-adopters. The two groups were different in these aspects: knowledge and skill of technology, teaching practices, teaching philosophy, technology needs, and characteristics. They perceived wireless technology attributes differently. They were in different stages of the technology diffusion process. They used different communication channels to share technology information. The innovators and the early adopters would quickly adopt the wireless technology. However, the majority of faculty members who had a more practical and deliberate perspective on wireless technology did not tend to adopt the technology if institutional factors (technology infrastructure and human infrastructure) were not in place.
CHAPTER FIVE: DISCUSSION

Introduction

This chapter summarizes the conclusions reached in this study and examines the findings in relation to the existing literature. Additional, the chapter discusses the implications from the study and suggests areas for future research.

This study was a qualitative study guided by Rogers’ diffusion theory to investigate and answer the following research questions:

1. How is wireless Internet technology perceived by faculty members of Ohio University, both adopters and non-adopters, in terms of relative advantage, compatibility, complexity, trialability, and observability?

2. What is the innovation-decision process of faculty members who adopt or do not adopt wireless technology?

3. What institutional factors influence the diffusion process of wireless technology among faculty members?

4. What teaching strategies and models are instructors developing in wireless environments?

5. How are classroom atmosphere, etiquette, and pedagogy changing in wireless environments?

6. What roles do administrators play at Ohio University in facilitating the diffusion of wireless technology?
To investigate the factors that influence the diffusion of wireless Internet among university faculty members, the study employed in-depth semi-structured interviews, classroom observations, and documentation analysis.

The interpretation of the study was guided by Rogers’ diffusion theory and the literature reviewed in Chapter 2. Rogers’ diffusion theory provided the theoretical framework to interpret and analyze these aspects: perceived attributes of the wireless technology, the innovation-decision process, adopters’ communication channels, and institutional factors. The study also examined wireless teaching practices, classroom etiquette and pedagogy, and the roles of administrators in technology diffusion.

Findings from this study showed that there were differences between early adopters and non-adopters. They were different in these aspects: technology knowledge and skill, teaching practices, teaching philosophy, technology needs, communication channels, and characteristics. They had different perceptions toward the wireless technology and they were at different diffusion stages. Therefore, these differences led to a diffusion “gap” between early adopters and non-adopters.

Bridging the Gap between Early Adopters and the Mainstream

* Differences between Early Adopters and Mainstream

Rogers (2003) said that the time element of the diffusion process allowed us to classify adopter categories and to draw diffusion curves. There are five categories of adopters: innovators, early adopters, early majority, late majority, and laggards. The segment of the diffusion curve between 10 to 20 percent adoption is the “heart of the
diffusion process,” and represents the transition from the “early adopter” to the “early majority.”

Moore (1999) extended Rogers’ adopter diffusion model, and added a gap between early adopters and the mainstream (the early majority and late majority). Moore called the gap a “chasm” in his book Crossing the Chasm. “Chasm” was defined as the gap between “visionaries,” early adopters who seize on new gadgets, and the mainstream “pragmatists” who need convincing before they adopt it.

Rogers’ (2003) diffusion theory provides an approach to discussing the differences between early adopters and the mainstream. Innovators are venturesome types who are risk takers. They usually enjoy technology for its own sake and they have an ability to understand and apply complex technical knowledge in their field. Their interest in new ideas leads them out of local peer networks.

Early adopters are a more integrated part of the local system than innovators. They are localities rather than cosmopolites. Early adopters have the greatest degree of opinion leadership in most systems, and potential adopters look to them for advice and information about the technology.

The mainstream are more deliberate and skeptical group, who have a wait-and-see attitude toward a technology. They want to see compelling value in an innovation before adopting it. Their adoption may be both an economic necessity and a result of increasing network pressure from peers. They usually do not adopt a technology until most others have done so, and social norms are in favor of it.
Literature about instructional technology also described the significant differences between early faculty adopters and the mainstream faculty. Geoghegan (1998) stated that early adopters, who are risk takers, are more willing to experiment, generally self-sufficient, and interested in the technology itself. Mainstream faculty, on the other hand, are more concerned about the teaching and learning problems being addressed than the technology used to address it. Mainstream faculty view ease of use as critical, and want proven applications with low risk of failure. They usually require strong technical support (Appendix D: Table 5.1).

Jacobson (1988) had the similar findings from the research on faculty innovativeness with technology for teaching and learning at two universities. She stated that early adopters often had different perceptions about obstacles to computer use than later adopting, mainstream faculty. While a majority of faculty agreed that lack of funds for hardware and the lack of technical support were obstacles, a larger percentage of mainstream faculty viewed the lack of technical support as more problematic than early adopters. Early adopters were more self-sufficient with regards to support and wanted more access to hardware resources for experimentation. Early adopters use computer technology mainly through self-training and assistance from colleagues.

In the wireless technology study, the similar differences were found between early adopters and mainstream faculty. The innovators or early adopters of wireless technology were intrinsically motivated, self-taught, and experimenters, who were confident and efficacious in technology. Their teaching philosophy and practices tended to be based on social constructivism and student-centered learning. On the other hand, the mainstream
faculty members were more intimidated with new technology and needed different kinds of supports than early adopters, such as user-friendly manual, guide, additional training or incentives.

*Perceived Technology Attributes*

Apart from the characteristics of adopters, we also need to consider the technology itself, the attributes of an innovation that make it attractive or unattractive to potential adopters.

Rogers (2003) stated that five attributes of innovations influence their rate of adoption. If an innovation performs well on these attributes, with good relative advantage, excellent compatibility with existing practices and norms, a low level of complexity, ease of use on a trial basis, and easily observed results, it would be susceptible to rapid adoption. On the contrary, another innovation, which does poorly on some or all of these attributes, would be adopted much more slowly, or would fail to achieve any significant penetration into the mainstream.

Geoghegan (1998) commented that relative advantage may play the most important role in early adopter acceptance. Complexity, compatibility, and trialability, on the other hand, seem to have a much stronger influence on the mainstream, who are a more deliberate, pragmatic, and skeptical group. The more complex and advanced technologies progressed as far as the early adopters, but failed to reach the mainstream.

Geoghegan (1998) gave an example to illustrate his points. For example, a decade ago, multimedia and CD-ROM were commonly seen as the technologies most likely to foster improvements in teaching and learning. According to Figure 5.1 (Appendix D),
although the use of multimedia and CD-ROM was growing, their growth and adoption rates were outstripped by the use of the Internet and e-mail. He explained that Internet and e-mail scored high on complexity, compatibility, and trialability: they were not difficult to begin using; they were easy to try out; and they were compatible with academic values that emphasize communication and group work and active learning. On the other hand, multimedia and CD-ROM scored low on all three of these characteristics despite their generally accepted pedagogical advantage. The result is that the Internet and e-mail obtained mainstream acceptance, while multimedia and CD-ROM did not.

For the wireless technology in this study, it is perceived to have great instructional potential in teaching and learning by the early adopters and they have easily accepted the technology. However, it may not be compatible with the mainstream’s teaching values and philosophy. Wireless technology supports more a student-centered learning environment. Although it is easy to use, it has a low degree of trialability and observability. That is, not easy to try out for the first time and not obviously observable. Therefore, the wireless technology does not easily obtain mainstream faculty acceptance.

**Institutional Factors**

Adopters’ characteristics determine they are in different diffusion stages. The perceived attributes of a technology decide whether it will reach the mainstream. For the diffusion of instructional technology in higher education settings, there is another group of factors: institutional factors.

Jacobsen (1997) stated that administrators usually have the infrastructure-driven “if you build it, they will come” approach to technology integration on campus.
Administrators assume that once faculty get access to technology they will easily, automatically, and quickly change their teaching methods and course materials to take advantage of technology. Administrators tend to focus on demonstration projects using complex technologies and show it has positive benefits to transform education. They hope that faculty would recognize the benefits and power of instructional technology, and then follow and adopt the technology. An administrator in this study expressed this idea by saying:

*A1: We want to get the system out where people could use it. When people see it, hopefully they would be on board with our project.*

This belief may work well for early adopter faculty members who have technology skills and enthusiasm for the technology. However, it may not work for the mainstream faculty who are less familiar with the computer technology and need more support.

According to Jacobsen (1997), previous explanations for why universities were “stuck at the barricades” (Geoghegan, 1994a, p. 13) between early adopters and mainstream faculty focused on blame. Mainstream faculty members were blamed for being stuck in traditional methods of course delivery, were labeled as resistors and charged with negative attitudes towards technology. These explanations were based on a poor understanding of the difference between early adopters and mainstream faculty. Administrators, sometimes the early adopters themselves, wondered why the mainstream faculty were not jumping on board and getting with the technology program. The
challenge for faculty and administration, said Jacobsen (1997), is not to assign blame or
to attempt to fix faculty attitudes.

Geoghegan (1994a) believed that there were four reasons for the inability to move
the adoption of instruction to reach mainstream faculty.

- Ignorance of the gap. The first reason is the failure to recognize the gap between
early adopters and the mainstream, and then, to a lesser extent, to act in a
systematic way to resolve the problems it poses. We seem to assume a sort of
homogeneity of faculty willingness to experiment with and use instructional
technology, and do not recognize “qualitatively distinct subgroups with different
attitudes toward technology and its use in instruction” (p. 15).

- The technologists’ alliance. The technologists’ alliance includes faculty
innovators and early adopters, campus IT support organizations, and information
technology vendors. Ironically, while this alliance has fostered development of
instructional applications, it has also unknowingly worked to prevent the
dissemination of these technologies to the mainstream population. All these three
groups are focused on technology itself. Therefore, support usually comes in the
form of money and training for hardware and software (valued by the technical
community), rather than for assistance in teaching with technology; the focus of
attention usually falls on the applications that offer “more radical (and disruptive)
change instructional methods” rather than those that offer “the incremental
advances favored by the mainstream” (p. 17).
- Alienation of the mainstream. The successes that the early adopters achieve can alienate the mainstream. A good application that is produced by technically comfortable and self-sufficient early adopters may promise a radical improvement in teaching and learning. However, it may be perceived by the mainstream faculty as unreasonably high expectations that they may be unable to meet.

- Lack of a compelling reason to adopt. The mainstream faculty members need a compelling reason to use a technology. The technology will be one that performs an existing important task, or solves an existing problem in a markedly better way.

Ram and Jung (1994) pointed out that academics are trained to be critical and may be expected to make demands for justification of resource allocation. Because of their independent nature, academics might be skeptical of the use of educational technology (Gilbert, 1995). The challenge is to draft integration plans and design new education systems by understanding the complexity and interconnectedness of faculty social systems, communication channels, and patterns of diffusion. Ram and Jung (1994) recommended that a different support infrastructure is needed for mainstream faculty than that which sufficed for early adopters.

Universities traditionally have flat organizational structures with loosely coupled organizational units to provide the primary services of higher education (Bull et al., 1994). Traditional organizational structures of higher education are decentralization and local responsibility for decisions. Initiatives for the use of instructional technology in teaching and learning tend to come from early adopter individuals and research units. These individual initiatives and efforts, as well as decentralized investments in IT, scattered all
over an institution, are insufficient by themselves to fully develop the potential of instructional technology (Bull et al., 1994). Early adopters might be committed and enthusiastic in instructional technology. However, to make these efforts more widespread and their practices used more comprehensively, incentives, training, support and reward structures “from above” are needed to build a strong human infrastructure, as well as providing the technological infrastructure.

In this wireless technology study, there were successful practices in several departments. However, because of the decentralized organizational structure and academic freedom, these successful practices were not easily spread to other departments and faculty members. The communication channels between departments were minimal. The departments do not know what other departments were doing and what resources were available from other departments. Besides, the university did not fully recognize the gap between early adopters and the mainstream and that the two groups had different characteristics, motivation, and needs. Therefore, there was not a specific instructional technology support system for mainstream faculty members.

_Institution as a Change Agent_

Diffusion theories help us to understand why we were not so successful with the adoption of wireless technology. Universities are dealing with two distinct populations that have different interests and needs. The early adopters who have technology skills and enthusiasm need leading edge technology, advanced technical assistance, and funding for new projects. The mainstream faculty members who are less familiar with technology
need more time, incentives, on-going support, and instructional design assistance (Geoghegan, 1998; Jacobsen, 1998).

Change agents in the administration (from the president, to deans, to department heads), and early adopters and mainstream faculty, need to sit down to discuss an instructional technology integration plan to bridge the gap. The technology integration plan should address the needs of mainstream adopters, by capitalizing on the knowledge and skills of early adopters, and the support structures of various organizations. Mechanisms for sharing valuable information among faculty and administrators must be provided. The mainstream faculty members need to contribute their point of view, their motivations, and their needs so that a common ground can be reached (Gilbert, 1996).

This following section will discuss the implication of the study and explain the roles of different stakeholders on the campus instructional technology integration plan.

*Early Adopters and Opinion Leaders*

Rogers (2003) said that early adopters have discovered and overcome barriers in their attempt to integrate this innovation, and have developed and contributed to a collective knowledge base concerning instructional technology. Early adopters make an innovation visible to the mainstream and decrease uncertainty about the innovation. They seek different uses of technology to solve novel problems and contribute to new and better uses of technology. The early adopters and opinion leaders can play an important role in the instructional technology integration plan on campus.
1. Early adopters’ knowledge and skills

There is valuable information to be gained from the early adopter’s knowledge and skills as a technology user and the mainstream’s reaction to being new users. Instructional technology designers should include both early adopters and mainstream faculty’s perspectives and feedback when developing systems and applications. Administration should include both early adopters and mainstream faculty in the development of technology integration plans and strategies. The role for early adopters in the knowledge and persuasion stages of adoption is to share what they have learned about instructional technology with the mainstream through in-house and across-discipline demonstrations and campus conferences.

2. Early adopters as peer mentors

Gilbert (1996) proposed another option for increasing the quality and availability of support services while holding down costs is to engage early adopters as peer mentors and thus increase the impact of their opinion leadership. Stipends, release time, and professional recognition through the merit system can be used to provide incentives for this type of knowledge sharing and interpersonal communication.

3. Early adopters as opinion leaders

Mass media channels, as knowledge creators, are often most important for informing people about an innovation, while interpersonal channels are more important in persuading someone to adopt a new idea. Early adopters play an important role because of their role as opinion leaders in communication channels and social systems. The transfer of ideas in a social system is most effective when participants belong to the same
groups or are drawn together by the same interests. Early adopters share characteristics and attributes that enhance communication among early adopters (Rogers, 2003).

Therefore, the interpersonal network is important to influence individuals in convincing them to adopt innovations. Opinion leaders are individuals who lead in influencing others’ opinions. Once opinion leaders adopt and begin telling others about an innovation, the number of adopters in the community will take off.

Ghandi had a vision about freedom and moved a whole nation to following his footsteps. One or two such opinion leaders are needed on campus, who believe in the value of information and instructional technology, and also possess the leadership characteristics needed in order to effect real change by converting the mainstream. A campus-wide culture that promotes adoption of technology can be developed by leaders at each level of the organizational structure. The idea was expressed by an administrator in this study.

A7: Well, faculty listen to and pay attention to other faculty. The strategy I am going to try to use in CITL to get more people to adopt and use technology, instead of going after innovator and early adopters, I am going to identify the opinion leaders. I don’t mean just the opinion leaders in terms of technology. I mean the opinion leaders in term of whatever topics it is, the other faculty tend to listen to that person. I can give some technologies to those opinion leaders to try, and share with others. That’s one. Because that’s a problem with the early adopters and innovators, (they) are not well respected by you majority people. They are the ones that are always with technology. You are not necessary the one
that other faculty will look to and go, “Oh, I am going to follow what they are doing.” It’s more likely that other faculty look to them and go, “Oh, they are always messing around with this stuff.” I also like to see the President and Provost coming out with the strong statements what they believe the role of technology is in improving teaching and learning in this institution, because they are leaders. We need the message from them. And it will help to be reinforced from the dean’s level and the department chair’s level.

In sum, there is much we can learn from early adopters about possible uses of technology. As opinion leaders, early adopters can persuade other mainstream faculty to adopt the use of technology.

The Mainstream Faculty

The mainstream faculty members are usually deliberate and skeptical toward technology. They have a wait-and-see attitude toward a new technology. The mainstream can play more active role in the technology integration plan.

- Participate in the technology planning

The mainstream faculty should participate in planning and decision-making activities that set the direction for instructional technology, such as strategic planning committees, university and department computing committees, technology task forces. The traditional model for staffing such groups tends to seek out faculty who are knowledgeable about technology and who have a strong interest in technology – innovators and early adopters. The mainstream faculty could be involved in these technology decision activities and committees to speak out about their needs and interests.
• Learn from successful practices

The mainstream faculty members usually need direction on where to start with the technology to integrate curriculum. They could look within their closely related discipline or profession by listening to colleagues’ successful practices and sharing experiences with them.

• An instructional team approach

In this study, the compatibility of the technology with the faculty’s teaching philosophy was an important factor that influenced the technology diffusion. Universities need to encourage the mainstream faculty to develop and implement technology based on their philosophy and pedagogy of teaching. Geoghegan (1998) recommended using an instructional team approach to design courses. Let faculty members serve as the content experts for the courses. Use an instructional designer to handle the pedagogical aspects. Employ a technologist to address issues related to hardware and software requirements. To be more effective, the instructional designer can explain the educational beliefs and philosophies behind the course redesign.

The Administrators

Change agents are individuals who influence “clients’ innovation-decisions in a direction deemed desirable by a change agency” (Rogers, 2003, p. 400). Rogers said that seven roles of change agents are: (1) to develop a need for change on the part of clients, (2) to establish an information-exchange relationship, (3) to diagnose problems, (4) to create an intent to change in the client, (5) to translate intentions into action, (6) to
stabilize adoption and prevent discontinuance, and (7) to achieve a terminal relationship with clients.

The administrators of a university should act as change agents to influence and transfer the use of instructional technology on campus. They can play an important role in these aspects.

- Articulate the vision of instructional technology

   First, the administrators should articulate the vision of the use of instructional technology to support learning and teaching. To build awareness of the possibilities and advantages of technology, early adopters from various disciplines can demonstrate how they develop applications and use them in class, and the administrators sponsor yearly technology conferences and symposia. In this study, an administrator stated how he viewed his role:

   *A6: One of my main roles is to try to articulate the vision of what we need to be thinking about and where this might go... The other is to be a cheerleader and to get people excited and find people their successes and good examples. We can help encourage them to do more and show others the new behavior we’d like to have.*

- Establish a technology information exchange network

   Second, the administrators should establish a technology information exchange network on campus. Universities are decentralized diffusion systems with a wide sharing of power and control among the members. Innovations in decentralized systems are created by certain lead users and may be not easy to reach other potential adopters (Bull
et al., 1994). Therefore, the administrators need to work with different departments and their opinion leaders. The administrators should capitalize on this valuable human resource that exists on campus and encourage early adopters to share their expertise with the mainstream. Such activities might include changes to the reward structure, release time for training, forging links with teaching development units, creation of training materials, and supporting symposia and conferences (Geoghegan, 1994b). Another way the administrators can capitalize on the knowledge of early adopters is by including them in the development of training modules that can be used by service units for workshops (Jacobsen, 1997).

- Diagnose technology problems experienced by the mainstream faculty

Third, the administrators need to diagnose technology problems from faculty, specially the mainstream faculty. The experiences of early adopters are valuable for other faculty. However, by making adoption look relatively easy, early adopters may unintentionally disguise the extensive knowledge and skills that mainstream faculty may be deficient in. The administrators should be aware of this and work closely with the mainstream faculty to solve the problems (Geoghegan, 1994a).

- Reward system

Fourth, the administrators need to modify the reward system to encourage and stabilize the use of instructional technology. This approach must address release time and the merit system for early adopters and the mainstream faculty, and the increased financial and human resource needs of service units. Early adopters might be committed and enthusiastic in developing new technology-based teaching methods, however, to
make these efforts more widespread and their results used more comprehensively, incentives, training, support and reward structures “from above” are needed to build a strong human infrastructure (Daigle & Jarmon, 1997), as well as providing the technological infrastructure. Incentives such as awards, annual reviews and promotions are rarely based on the use of instructional technology in teaching. Thus, faculty members focus on the areas that would give them these opportunities, such as research and publication. The effective teaching using technology contributes very little to tenure and promotion decisions. The possibility of publishing their experiences using technology for teaching may be a booster to influence their adoption the technology (Jacobsen, 1997).

The administrators need to address the reward system and commit to system-wide investment in IT in order to address the needs of mainstream faculty. Without investment in the human infrastructure, nothing of sustainable value will be achieved (Foa, 1993). The institutional reward system should be modified to recognize contributions of faculty and staff to reengineering courses, developing electronic media, and mastering a new set of skills.

- Promote a package of technologies.

According to Rogers’ concept of technology cluster (2003), the adoption of one technology may trigger or encourage the adoption of others. Change agents could promote a “package of innovations” because these innovations are adopted more rapidly. The use of technology for one purpose encourages future technology use and questions about other technologies and it will start a ripple effect throughout the institution
(Broholm, 1993). For example, if the university promotes wireless Internet with laptop programs, the faculty may adopt the technology package and benefit from ubiquitous computing for teaching and learning.

- Increase IT support personnel and professional development.

The main reasons that mainstream faculty hesitate to adopt are the lack of effective training and support (Jacobsen, 1997). Most institutions did reasonably well in the past at developing support services appropriate to the character and needs of early adopters, such as workshops, seminaries, orientations, and other sessions. However, these training and support might be adequate for early adopters. They are completely inadequate to meet the demands of the large number of the mainstream faculty. Therefore, proportionally more support and personnel will be required, and those providing it will need better and more varied interpersonal skills and sensitivity to deal with mainstream faculty (Jacobsen, 1997).

Gilbert (1996) suggested involving undergraduate/graduate students in the mainstream faculty development plan. Many graduates have better skills and knowledge about information technology than mainstream faculty. Student assistants can help increase the use of information technology for teaching and learning, and alleviate some of the financial and human resources costs of support units. This will result in a win-win situation for the institution, faculty, and students.

- Technology infrastructure and support

Technology infrastructure is needed to encourage adoption and integration. Ready access is provided to up-to-date, stable and reliable technology. Technical support for
both hardware and software is provided by the university for acquisition, installation, information and implementation

**Recommendations for Future Research**

The following recommendations could be used as a basis for future research to deepen our understanding of instructional technology diffusion in higher education.

1. The study investigated faculty members’ adoption of the wireless technology at a public state university. Further research is needed to understand faculty technology adoption in a wide range of colleges and universities.

2. The study focused on only the wireless technology adoption among faculty members. Future research could be expanded to other instructional technology, such as, e-mail, multimedia software, BlackBoard, e-portfolio, etc. It would be interesting to investigate the different diffusion rates among these instructional technologies and to see whether there is the same diffusion “gap” between early adopters and the mainstream.

3. There is still a great deal to learn about early adopters of instructional technology as a subgroup of the faculty population. There is a need for case study research that profiles individual early adopters of technology who are excellent teachers to serve as role models and provide guidance in this innovative, constantly changing, and exciting area.

4. Future research is needed to examine the adoption of the wireless technology over time. This study was conducted at an early stage of adoption of the wireless technology and there were not so many faculty members who had adopted it.
Further research is needed to identify adopter categories, particularly to examine the needs and perceptions of the mainstream faculty (the early majority and late majority).

5. Future research is needed on variance-type quantitative research. This study is a process research that focused on the technology diffusion process among faculty members and discovered the teaching strategies and models in wireless environments, which helped us understand the meaning and context of wireless technology diffusion among faculty members in real life natural settings.

Diffusion theory provides well-developed concepts and provides tools for both quantitative and qualitative research. Further variance research is needed to determine covariances (or correlations) among set of variables about wireless technology. These variables may include attributes of the technology, personal technology skill, personal innovativeness, and end user support.

Conclusion

The results presented in this study have both theoretical and practical significance. This study found additional evidences to support Rogers’ (2003) theory of the diffusion of innovations. Based on findings at this institution, there is a diffusion gap between early adopters and the mainstream faculty in wireless technology adoption. This diffusion gap implies that a different support infrastructure is needed for mainstream faculty to integrate technology for teaching and learning. There is growing recognition of the need to provide a different support infrastructure for mainstream faculty to bridge the gap between early adopter’s success and more mainstream adoption.
Like wireless technology, many instructional technologies are widespread adopted by innovators and early adopters, but limitedly adopted by the mainstream faculty. These two groups have different characteristics, motivations, and needs in instructional technology. If the technology integration plans are developed on the assumption that everyone will naturally use technology as readily and easily as the early adopters, then they are bound to fail. Therefore, we need to recognize that the mainstream faculty members have different characteristics and needs. Instead of relying on serendipitous diffusion to bridge the “chasm” between early adopters and the mainstream faculty, the technology integration plan needs to combine the different stakeholders’ perspectives and interests, including early adopters and opinion leaders, the mainstream, and the administrators.

This study identified the need for the institution as a change agent by providing additional training, support and personnel, modifying the reward system, providing a technological infrastructure, encouraging interpersonal communication channels, and capitalizing on the opinion leadership and evangelistic qualities of early adopters to promote further adoption by the mainstream. Strategies are needed to promote more widespread dissemination of learned successful strategies, methods and models to improve teaching and learning using technology.

Institutions should understand that expectations for the instructional technology integration plan will not materialize overnight. Technology integration takes time. Faculty members and educational institutions are more likely to participate in gradual change rather than making sudden, dramatically change (Gilbert, 1996). Developing
increased awareness of instructional technology is a complex and time-consuming process. A long-term strategy for technology integration is needed rather than focusing on quick results and rapid adoption. Faculty support in the form of incentives, rewards, time, access, training, and additional personnel in support units will be necessary to improve chances of success, quality, and efficiency.
References


Ely, D. P. (1990a). *The diffusion and implementation of educational technology in developing nations: Cross-cultural comparisons of Indonesia, Chile, and Peru.* (ERIC Document Reproduction Service No. ED 331 469)


Ely, D. P. (1999b). *New perspectives on the implementation of educational technology innovation.* (ERIC Document Reproductive Service No. ED427 775)


http://teach.citl.ohiou.edu/wireless/index.htm


Appendix A: Introductory Emails Sent to Research Participants

Dear ____,

I am a doctoral student in Instructional Technology in the College of Education. I am currently collecting data for my dissertation. I am interviewing faculty members (full-time and part-time) to investigate the diffusion of wireless Internet among faculty members at Ohio University. The major aim of my study is to find what factors influence the diffusion of wireless Internet among faculty members. CNS is expanding wireless Internet coverage to the whole campus in a two-year implementation cycle, and then to “create a ubiquitous and seamless wireless computing environment”. Wireless Internet is affecting not just the classroom environment and technology access, but also the actual activities of learning and teaching.

Consequently, I am concerned with the innovation-decision process of faculty members to adopt or not adopt wireless Internet, the innovative teaching strategies and models instructors are developing in wireless environments, and the roles of administrators of the University in the diffusion of wireless Internet.

I am asking for your assistance and participation in this study by allowing me to have half an hour interview session with you.

I’d like to thank you for your time. Your participation is very important to my research!

Sincerely yours,

Yong (Eric) Lu
Appendix B: Ohio University Consent Form

Title of Research: The Diffusion of Wireless Internet among Faculty Members at Ohio University
Principal Investigator: Yong Lu
Co-Investigator: 
Department: Educational Studies

Federal and university regulations require signed consent for participation in research involving human subjects. After reading the statements below, please indicate your consent by signing this form.

Explanation of Study

The purpose of the study is to investigate what factors influence the diffusion of wireless Internet among faculty members. Your participation is voluntary and your responses will be kept confidential. The study involves an interview that takes approximately an hour to complete.

Risks and Discomforts

There are no known risks involved in this study.

Benefits

Wireless Internet has great benefits to education and “many institutions believe this access will encourage greater collaboration, resulting in better learning, research and creative scholarship”. However, not many faculty members take advantage of the technology and integrate it into their teaching and curriculum. The study will focus on the innovation-decision process of faculty members to identify factors that influence their decision to adopt or not adopt wireless Internet in their academic endeavors.

Alternative Treatments (if applicable)

N/A

Confidentiality and Records

The interview transcripts, field notes and other records of the study will be only accessible to the researcher.

Compensation

N/A

Contact Information

If you have any questions regarding this study, please contact (Researcher/Advisor & email/phone number).
<table>
<thead>
<tr>
<th>Name</th>
<th>Yong Lu</th>
<th>Dr. Sandra Turner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td><a href="mailto:Lu@ohio.edu">Lu@ohio.edu</a></td>
<td><a href="mailto:turners@ohio.edu">turners@ohio.edu</a></td>
</tr>
<tr>
<td>Tel</td>
<td>594-2483</td>
<td>593-9826</td>
</tr>
</tbody>
</table>

If you have any questions regarding your rights as a research participant, please contact Jo Ellen Sherow, Director of Research Compliance, Ohio University, (740)593-0664.

I certify that I have read and understand this consent form and agree to participate as a subject in the research described. I agree that known risks to me have been explained to my satisfaction and I understand that no compensation is available from Ohio University and its employees for any injury resulting from my participation in this research. I certify that I am 18 years of age or older. My participation in this research is given voluntarily. I understand that I may discontinue participation at any time without penalty or loss of any benefits to which I may otherwise be entitled. I certify that I have been given a copy of this consent form to take with me.

Signature_________________________________________ Date_____
Printed Name________________________________________
Appendix C: Interview Questions

Part 1: Interview Questions for Faculty Adopters

1. Factors that influence to use wireless technology

1) First, could you please tell me a little bit about yourself?
   Probe 1: What courses do you teach?
   Probe 2: How long have you taught at Ohio University?

2) Can you describe your instructional technology (computer technology) level?
   Novice, intermediate, or expert?
   Probe 1: What computer skills do you have? Such as what programs you used, or what do you do using computers?
   Probe 2: In your view, how does technology add value to the teaching and learning process?

3) Did you receive any instruction about effective use of wireless technology? If yes, what are these instructions? If no, how did you gain skills to use wireless Internet?
   Probe 1: What aids or supports would you use for wireless Internet?
   Probe 2: What types of technical support have you found to be most helpful?

4) Do you think whether it will change your teaching style in some ways if using wireless Internet in classrooms?

5) What problems or concerns do you have about using wireless Internet? How comfortable do you feel about using it? What personal value do you see in using it? Do you have any other reservations about it?
6) What do you consider to be a sensible balance of payoff or value vs. the time it takes to learn how to use wireless Internet?

7) What roles do administrators play in facilitating the diffusion of wireless Internet?

8) Who play an important role in the project?

2. Innovation-decision process

1) You are one of the faculty members using wireless Internet technology at Ohio University. Could you please tell me how you learned about wireless technology?

   Probe 1: When were you first aware of the technology?

2) What triggered your decision to use wireless Internet?

3) How did you come to the final decision of using wireless Internet?

4) Do faculty and administrators in your department and college discuss about the use of wireless Internet? If yes, what are some of the views regarding it?

   Probe 1: To what extent have you learned about wireless Internet from your colleagues?

   Probe 2: Are you cooperating your using of wireless Internet with other faculty members?

3. Perceived attributes of wireless Internet

1) To what extent do you use wireless Internet?
Probe 1: How do you use wireless Internet? Such as, locating instructional material, sharing or disseminating information, accessing electronic articles, communicating, or others.

Probe 2: what was your most memorable experience with wireless Internet? What caused that experience to be so memorable?

Probe 3: Could you describe how you use technology in teaching your class?

2) How do you feel about wireless Internet? What do you think of it? What is your attitude toward it?

Probe 1: What are the advantages of wireless Internet compared to wired Internet? Such as for your teaching, research, and communication.

Probe 2: Any problems or concern you have about it? Do you have any reservation about it?

3) What are the factors that attract you to use wireless Internet in your teaching?

4) How did the students response to your using wireless technology in your teaching in your classroom? What did the students say about your technology use?

5) Does it require a lot of training and practice to use wireless Internet?

6) Is it possible to integrate wireless Internet into your teaching, research, and management?

Probe 1: Is it possible for an instructor to combine wireless Internet with other methods to teach in a classroom? If yes, in which ways? If no, why not?
7) Are there other possible ways that you might discover or hear from your colleagues that you can use wireless Internet?

8) Did you meet any problems when using wireless Internet? If yes, how did you solve it? Did you get any assistant?
   Probe 1: Did you have any problem to set up the wireless Internet device (driver)?

9) How does wireless Internet affect you or others you know?
   Probe 1: Do you feel that wireless Internet is compatible with your own lifestyle or personal philosophy?
   Probe 2: How does it fit into your teaching philosophy?
   Probe 3: What kinds of changes are you making in your use of wireless Internet?

4. Others

1) What are your expectations for wireless Internet implementation?

2) How do you feel that your students using wireless Internet in class?

3) How do you see the classroom atmosphere, etiquette, and pedagogy changing in wireless environments?

4) What advices would you like to give to other faculty members about using wireless Internet?

5) Is there any particular topic you would like to comment on that we haven’t covered today?
Part 2: Interview Questions for Faculty Non-adopters

1. Factors that influence to use the wireless technology

   1) First, could you please tell me a little bit about yourself?
      
      Probe 1: What courses do you teach?
      
      Probe 2: How long have you taught at Ohio University?

   2) Can you describe your instructional technology (computer technology) level?
      
      Novice, intermediate, or expert?
      
      Probe 1: What computer skills do you have? Such as what programs you used, or what do you do using computers?
      
      Probe 2: In your view, how does technology add value to the teaching and learning process?
      
      Probe 3: Could you describe how you use technology in teaching your class?

   3) Did you receive any instruction about effective use of wireless technology? If yes, what are these instructions? If no, how did you gain skills to use wireless Internet?
      
      Probe 1: What aids or supports would you use for wireless Internet?
      
      Probe 2: What types of technical support have you found to be most helpful?

   4) Do you think whether it will change your teaching style in some ways if using wireless Internet in classrooms?

   5) What roles do administrators play in facilitating the diffusion of wireless Internet?

   6) Who play an important role in the project?
2. Innovation-decision process
   1) Do you know any information about wireless Internet technology? If yes, Could you please tell me how you got to know the information?
   Probe 1: Do you know any information about the wireless Internet project at Ohio University? If yes, Could you please tell me how you got to know the information?
   Probe 2: Are you currently looking for information about wireless Internet?
   2) Have you ever considered using wireless Internet?
   3) Do faculty and administrators discuss in your department and college about the use of wireless Internet? If yes, what are some of the views regarding it?

3. Perceived attributes of wireless Internet
   1) How do you feel about wireless Internet? What do you think of it? What is your attitude toward it?
   2) From your viewpoint, what are the advantages of wireless Internet compared to wired Internet? Such as teaching, research, and communication.
   3) How do you envision yourself using wireless Internet to support your teaching, research, or communication?
   Probe 1: Is it possible for an instructor to combine wireless Internet with other methods to teach in a classroom? If yes, in which ways? If no, why not?
   4) Are there other possible ways that you might discover or hear from your colleagues that you can use wireless Internet?

4. Others
   1) What are your expectations for wireless Internet implementation?
2) How do you feel that your students using wireless Internet in class?

3) How do you see the classroom atmosphere, etiquette, and pedagogy changing in wireless environments?

4) What advices would you like to give to other faculty members about using wireless Internet?

5) Is there any particular topic you would like to comment on that we haven’t covered today?
Part 3: Interview Questions for Administrators

1. Factors that influence to use the wireless technology

1) First, could you please tell me a little bit about yourself?

   Probe 1: which department are you in?

   Probe 2: How long have you worked at Ohio University?

   Probe 3: In your view, how does technology add value to the teaching and learning process?

   Probe 4: what’s your viewpoint about technology and professional development?

2) Is there any problem reported by the faculty associated with the use of wireless Internet? If yes, what are they and how do you deal with these problems?

3) How does the incentive structure of Ohio University influence the use of Wireless Internet?

4) What are the current difficulties to implement wireless Internet?

5) What kinds of supports do you think faculty members need in order to effectively use wireless Internet?

2. Innovation-decision process

1) What concerns led to the decision to implement wireless Internet at Ohio University?

2) How did you come to the decision to adopt wireless Internet at Ohio University?

3) How do you inform the faculty and staff about wireless Internet technology?

   How do you introduce the technology to novice faculty members?
4) As for wireless project at Ohio University, what the roles of the University and your department play in the implementation of the technology?

3. Perceived attributes of wireless Internet

1) To what extent do you use wireless Internet?

   Probe 1: How do you use wireless Internet? Such as, locating instructional material, sharing or disseminating information, accessing electronic articles, communicating, or others.

   Probe 2: what was your most memorable experience with wireless Internet? What caused that experience to be so memorable?

   Probe 3: Could you describe how you use technology?

2) How do you feel about wireless Internet? What do you think of it? What is your attitude toward it?

   Probe 1: What are the advantages of wireless Internet compared to wired Internet? Such as for your teaching, research, and communication.

   Probe 2: Any problems or concern you have about it? Do you have any reservation about it?

3) Please give a brief description of how wireless Internet helps faculty members in teaching, research, and communication.

4) How long does it take for faculty members to learn and be competent in use wireless Internet?

5) Do faculty and administrators discuss in your department and college about the use of wireless Internet? If yes, what are some of the views regarding it?
6) Does it require a lot of training and practice to use wireless Internet?

7) Is it possible to integrate wireless Internet into your teaching, research, and management?

4. Others

1) Do you evaluate the effectiveness of using wireless Internet?

2) What other comments do you give to faculty members regarding the use of wireless Internet?

3) What are your expectations for wireless Internet implementation?

4) How do you feel that your students using wireless Internet in class?

5) How do you see the classroom atmosphere, etiquette, and pedagogy changing in wireless environments?

6) What advices would you like to give to faculty members about using wireless Internet?

7) Is there any particular topic you would like to comment on that we haven’t covered today?
Appendix D: List of Figures and Tables

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Figure 1.1. Percentage of wireless networks by sector, 2000-2003.

Figure 1.2. Number of unique wireless users.

Figure 2.1. Adopter categories.


*Note.* The innovativeness variable is partitioned into five adopter categories by laying off standard deviations (sd) from the average time of adoption (x).
Figure 2.2. S-shaped curve of diffusion showing critical mass.

Figure 2.3. Revised figure of adopter categories.

Figure 5.1. Growth in instructional technology.

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<th>Relative advantage</th>
<th>Compatibility</th>
<th>Complexity</th>
<th>Trialability</th>
<th>Observability</th>
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<td></td>
<td></td>
</tr>
<tr>
<td>Innovation-decision process</td>
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<td>Persuasion stage</td>
<td>Decision stage</td>
<td>Implementation stage</td>
<td>Confirmation stage</td>
</tr>
<tr>
<td>Adopter categories</td>
<td>Innovators</td>
<td>Early adopters</td>
<td>Early majority</td>
<td>Late majority</td>
<td>Laggards</td>
</tr>
<tr>
<td>Social system</td>
<td>Social norm</td>
<td>Types of innovation-decision</td>
<td>Opinion leaders</td>
<td>Change agents</td>
<td></td>
</tr>
</tbody>
</table>
Table 2.2. Factors affecting the adoption of an instructional product.

<table>
<thead>
<tr>
<th>Factors Affecting Adoption</th>
<th>Individual Factors</th>
<th>Organizational Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Characteristics</td>
<td>Perceived Attributes</td>
<td>Physical environment</td>
</tr>
<tr>
<td>Motivation</td>
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<td>Patterns of Use</td>
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<td>Anxiety</td>
<td>Complexity</td>
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<tr>
<td>Knowledge Base</td>
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<tr>
<td>Prior Experience</td>
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<td>Skill Level</td>
<td>Trialability</td>
<td>Administrator Characteristics</td>
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<td></td>
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<td>Support Resources</td>
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Table 2.3. Conditions that facilitate technology implementation.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
<th>Linked to</th>
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<tbody>
<tr>
<td>1. Dissatisfaction</td>
<td>Feel a need to</td>
<td>Leadership</td>
</tr>
<tr>
<td>2. Knowledge and skills</td>
<td>Access to knowledge and skills required by the user</td>
<td>Resources, rewards &amp; incentives, leadership, commitment</td>
</tr>
<tr>
<td>3. Availability of resources</td>
<td>Funding, software, equipment, personnel</td>
<td>Commitment, leadership, rewards &amp; incentives</td>
</tr>
<tr>
<td>4. Availability of time</td>
<td>Allocation of time</td>
<td>Participation, commitment, leadership, reward &amp; incentives</td>
</tr>
<tr>
<td>5. Rewards or incentives</td>
<td>Internal and external motivators</td>
<td>Participation, resources, time, dissatisfaction</td>
</tr>
<tr>
<td>6. Participation</td>
<td>Shared decision-making, full communication</td>
<td>Time, knowledge &amp; skill, rewards &amp; incentives</td>
</tr>
<tr>
<td>7. Commitment</td>
<td>Continuing support</td>
<td>Leadership, time resources, rewards &amp; incentives</td>
</tr>
<tr>
<td>8. Leadership</td>
<td>Competent and supportive leaders</td>
<td>Participation, commitment, time, resources, rewards &amp; incentives.</td>
</tr>
</tbody>
</table>

Table 2.4. Conditional linkages as identified by Ely.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Dissatisfaction</th>
<th>Knowledge</th>
<th>Resources</th>
<th>Time</th>
<th>Rewards &amp; Incentives</th>
<th>Participation</th>
<th>Commitment</th>
<th>Leadership</th>
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<tbody>
<tr>
<td>Dissatisfaction</td>
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<td>Knowledge</td>
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<td>Rewards &amp; Incentives</td>
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<td>Participation</td>
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<td>Commitment</td>
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<td>Leadership</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.5. Percentage of institutions reporting types of users.

<table>
<thead>
<tr>
<th>Users</th>
<th>Total (N=299)</th>
<th>FTE: 1–4,999 (N=154)</th>
<th>FTE: 5,000–9,999 (N=50)</th>
<th>FTE: 10,000–19,999 (N=45)</th>
<th>FTE: 20,000+ (N=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergrads</td>
<td>77%</td>
<td>77%</td>
<td>78%</td>
<td>76%</td>
<td>75%</td>
</tr>
<tr>
<td>Faculty</td>
<td>73%</td>
<td>65%</td>
<td>80%</td>
<td>73%</td>
<td>90%</td>
</tr>
<tr>
<td>Administration</td>
<td>53%</td>
<td>45%</td>
<td>52%</td>
<td>69%</td>
<td>85%</td>
</tr>
<tr>
<td>Grad Students/Researchers</td>
<td>44%</td>
<td>27%</td>
<td>56%</td>
<td>53%</td>
<td>95%</td>
</tr>
<tr>
<td>Other</td>
<td>6%</td>
<td>6%</td>
<td>10%</td>
<td>2%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Table 2.6. Students with access to wireless networks by Carnegie classification.

Table 2.7. Departments reported to have wireless access.

<table>
<thead>
<tr>
<th>Department</th>
<th>Total (N=299)</th>
<th>Doctoral (N=64)</th>
<th>Master’s (N=75)</th>
<th>Bachelor’s (N=62)</th>
<th>Associate’s (N=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Sciences</td>
<td>38%</td>
<td>47%</td>
<td>36%</td>
<td>22%</td>
<td>18%</td>
</tr>
<tr>
<td>Physical Sciences</td>
<td>33%</td>
<td>41%</td>
<td>32%</td>
<td>34%</td>
<td>36%</td>
</tr>
<tr>
<td>Business</td>
<td>32%</td>
<td>55%</td>
<td>33%</td>
<td>19%</td>
<td>14%</td>
</tr>
<tr>
<td>Languages/History</td>
<td>23%</td>
<td>23%</td>
<td>17%</td>
<td>27%</td>
<td>25%</td>
</tr>
<tr>
<td>Engineering</td>
<td>21%</td>
<td>47%</td>
<td>13%</td>
<td>5%</td>
<td>14%</td>
</tr>
<tr>
<td>Social Science</td>
<td>21%</td>
<td>23%</td>
<td>19%</td>
<td>31%</td>
<td>11%</td>
</tr>
<tr>
<td>Math</td>
<td>18%</td>
<td>27%</td>
<td>13%</td>
<td>21%</td>
<td>11%</td>
</tr>
<tr>
<td>Law</td>
<td>10%</td>
<td>31%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>Medical</td>
<td>10%</td>
<td>23%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Other</td>
<td>39%</td>
<td>25%</td>
<td>57%</td>
<td>37%</td>
<td>43%</td>
</tr>
</tbody>
</table>

Table 3.1. Faculty Participants.

<table>
<thead>
<tr>
<th>College of Arts &amp; Sciences</th>
<th>Wireless adopters</th>
<th>Wireless non-adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td>College of Education</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>College of Communication</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>College of Health and Human Services</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>College of Fine Arts</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Russ College of Engineering and Technology</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>7</td>
</tr>
</tbody>
</table>
Table 4.1. The number of faculty members reaching each stage of the innovation-decision process.

<table>
<thead>
<tr>
<th>Total number</th>
<th>Knowledge</th>
<th>Persuasion</th>
<th>Decision</th>
<th>Implementation</th>
<th>Confirmation</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>14</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Table 5.1. Early adopters versus the early majority.

<table>
<thead>
<tr>
<th>Early Adopters</th>
<th>Early Majority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favor revolutionary change</td>
<td>Favor evolutionary change</td>
</tr>
<tr>
<td>Visionary</td>
<td>Pragmatic</td>
</tr>
<tr>
<td>Project oriented</td>
<td>Process oriented</td>
</tr>
<tr>
<td>Risk takers</td>
<td>Risk averse</td>
</tr>
<tr>
<td>Willing to experiment</td>
<td>Want proven applications</td>
</tr>
<tr>
<td>Generally self-sufficient</td>
<td>May need significant support</td>
</tr>
<tr>
<td>Horizontally connected</td>
<td>Vertically connected</td>
</tr>
</tbody>
</table>


Note: “Horizontal” refers here to personal networks that have a high proportion of interdisciplinary and crossfunctional links; “vertical” refers to networks whose links are more concentrated within a single discipline or discipline area.