DETAILED REVIEW OF ROGERS' DIFFUSION OF INNOVATIONS THEORY AND EDUCATIONAL TECHNOLOGY-RELATED STUDIES BASED ON ROGERS' THEORY

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The process of adopting new innovations has been studied for over 30 years, and one of the most popular adoption models is described by Rogers in his book, *Diffusion of Innovations* (Sherry & Gibson, 2002). Much research from a broad variety of disciplines has used the model as a framework. Dooley (1999) and Stuart (2000) mentioned several of these disciplines as political science, public health, communications, history, economics, technology, and education, and defined Rogers' theory as a widely used theoretical framework in the area of technology diffusion and adoption.

Rogers' diffusion of innovations theory is the most appropriate for investigating the adoption of technology in higher education and educational environments (Medlin, 2001; Parisot, 1995). In fact, much diffusion research involves technological innovations so Rogers (2003) usually used the word "technology" and "innovation" as synonyms. For Rogers, "a *technology* is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome" (p. 13). It is composed of two parts: hardware and software. While hardware is "the tool that embodies the technology in the form of a material or physical object," software is "the information base for the tool" (Rogers, 2003, p. 259). Since software (as a technological innovation) has a low level of observability, its rate of adoption is quite slow.

For Rogers (2003), adoption is a decision of "full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation" (p. 177). Rogers defines diffusion as "the process in which an innovation is communicated thorough certain channels over time among the members of a social system" (p. 5). As expressed in this definition, innovation, communication channels, time, and social system are the four key components of the diffusion of innovations.

Four Main Elements in the Diffusion of Innovations

Innovation

Rogers offered the following description of an innovation: "An *innovation* is an idea, practice, or project that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12). An innovation may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them. The newness characteristic of an adoption is more related to the three steps (knowledge, persuasion, and decision) of the innovation-decision process that will be discussed later. In addition, Rogers claimed there is a lack of diffusion research on technology clusters. For Rogers (2003), "a technology cluster consists of one or more distinguishable elements of technology that are perceived as being closely interrelated" (p. 14).

Uncertainty is an important obstacle to the adoption of innovations. An innovation's consequences may create uncertainty: "*Consequences* are the changes that occur in an individual or a social system as a result of the adoption or rejection of an innovation" (Rogers, 2003, p. 436). To reduce the uncertainty of adopting the innovation, individuals should be informed about its advantages and disadvantages to make them aware of all its consequences. Moreover, Rogers claimed that consequences can be classified as desirable versus undesirable (functional or dysfunctional), direct versus indirect (immediate result or result of the immediate result), and anticipated versus unanticipated (recognized and intended or not).

Communication Channels

The second element of the diffusion of innovations process is communication channels. For 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). This communication occurs through channels between sources. Rogers states that "a *source* is an individual or an institution that originates a message. A channel is the means by which a message gets from the source to the receiver" (p. 204). Rogers states that diffusion is a specific kind of communication and includes these communication elements: an innovation, two individuals or other units of adoption, and a communication channel. *Mass media* and *interpersonal communication* are two communication channels. While mass media channels include a mass medium such as TV, radio, or newspaper, interpersonal channels consist of a two-way communication between two or more individuals. On the other hand, "diffusion is a very social process that involves interpersonal communication relationships" (Rogers, 2003, p. 19). Thus, interpersonal channels are more powerful to create or change strong attitudes held by an individual. In interpersonal channels, the communication may have a characteristic of *homophily*, that is, "the degree to which

two or more individuals who interact are similar in certain attributes, such as beliefs, education, socioeconomic status, and the like," but the diffusion of innovations requires at least some degree of heterophily, which is "the degree to which two or more individuals who interact are different in certain attributes." In fact, "one of the most distinctive problems in the diffusion of innovations is that the participants are usually quite heterophilous" (Rogers, 2003, p. 19).

Communication channels also can be categorized as *localite channels* and *cosmopolite channels* that communicate between an individual of the social system and outside sources. While interpersonal channels can be local or cosmopolite, almost all mass media channels are cosmopolite. Because of these communication channels' characteristics, mass media channels and cosmopolite channels are more significant at the knowledge stage and localite channels and interpersonal channels are more important at the persuasion stage of the innovation-decision process (Rogers, 2003).

Time

According to Rogers (2003), the time aspect is ignored in most behavioral research. He argues that including the time dimension in diffusion research illustrates one of its strengths. The innovation-diffusion process, adopter categorization, and rate of adoptions all include a time dimension. These aspects of Rogers' theory will be discussed later in more detail.

Social System

The social system is the last element in the diffusion process. Rogers (2003) defined the social system as "a set of interrelated units engaged in joint problem solving to accomplish a common goal" (p. 23). Since diffusion of innovations takes place in the social system, it is influenced by the social structure of the social system. For Rogers (2003), structure is "the patterned arrangements of the units in a system" (p. 24). He further claimed that the nature of the social system affects individuals' innovativeness, which is the main criterion for categorizing adopters.

The Innovation-Decision Process

Rogers (2003) described the innovation-decision process as "an information-seeking and information-processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation" (p. 172). For Rogers (2003), the innovation-decision process involves five steps: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. These stages typically follow each other in a time-ordered manner. This process is shown in Figure 2.1.

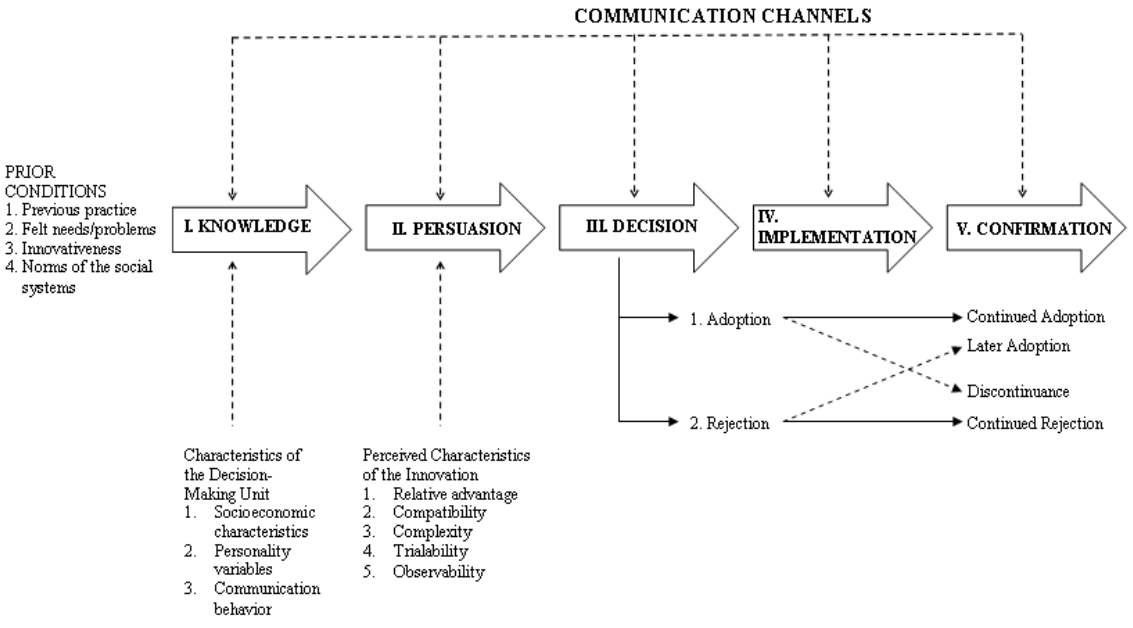

Figure 2.1. A Model of Five Stages in the Innovation-Decision Process (Source: *Diffusion of Innovations, Fifth Edition* by Everett M. Rogers. Copyright (c) 2003 by The Free Press. Reprinted with permission of the Free Press: A Division of Simon & Schuster.)

The Knowledge Stage

The innovation-decision process starts with the knowledge stage. In this step, an individual learns about the existence of innovation and seeks information about the innovation. "What?," "how?," and "why?" are the critical questions in the knowledge phase. During this phase, the individual attempts to determine "what the innovation is and how and why it works" (Rogers, 2003, p. 21). According to Rogers, the questions form three types of knowledge: (1) awareness-knowledge, (2) how-to-knowledge, and (3) principles-knowledge.

- Awareness-knowledge: Awareness-knowledge represents the knowledge of the innovation's existence. This type of knowledge can motivate the individual to learn more about the innovation and, eventually, to adopt it. Also, it may encourage an individual to learn about other two types of knowledge.
- How-to-knowledge: The other type of knowledge, how-to-knowledge, contains information about how to use an innovation correctly. As Wetzel (1993) stated, even the faculty who have technical backgrounds may not use technology in teaching, if they do not have knowledge of how to use it correctly. Thus, technology is not used at an expected level, since they need help in how to use the technology effectively in teaching (Spotts, 1999). Rogers saw this knowledge as an essential variable in the innovation-decision process. To increase the adoption chance of an innovation, an individual should have a sufficient level of how-to-knowledge prior to the trial of this innovation. Thus, this knowledge becomes more critical for relatively complex innovations.
- Principles-knowledge: The last knowledge type is principles-knowledge. This knowledge includes the functioning principles describing how and why an innovation works. An innovation can be adopted without this knowledge, but the misuse of the innovation may cause its discontinuance. For Sprague et al. (1999), the biggest barrier to faculty use of technology in teaching was that faculty lack a vision of why or how to integrate technology in the classroom.

To create new knowledge, technology education and practice should provide not only a how-to experience but also a know-why experience (Seemann, 2003). In fact, an individual may have all the necessary knowledge, but this does not mean that the individual will adopt the innovation because the individual's attitudes also shape the adoption or rejection of the innovation.

The Persuasion Stage

The persuasion step occurs when the individual has a negative or positive attitude toward the innovation, but "the formation of a favorable or unfavorable attitude toward an innovation does not always lead directly or indirectly to an adoption or rejection" (Rogers, 2003, p. 176). The individual shapes his or her attitude after he or she knows about the innovation, so the persuasion stage follows the knowledge stage in the innovation-decision process. Furthermore, Rogers states that while the knowledge stage is more cognitive- (or knowing-) centered, the persuasion stage is more affective- (or feeling-) centered. Thus, the individual is involved more sensitively with the innovation at the persuasion stage. The degree of uncertainty about the innovation's functioning and the social reinforcement from others (colleagues, peers, etc.) affect the individual's opinions and beliefs about the innovation. Close peers' subjective evaluations of the innovation that reduce uncertainty about the innovation outcomes are usually more credible to the individual: "While information about a new innovation is usually available from outside experts and scientific evaluations, teachers usually seek it from trusted friends and colleagues whose subjective opinions of a new innovation are most convincing" (Sherry, 1997, p. 70). Individuals continue to search for innovation evaluation information and messages through the decision stage.

The Decision Stage

At the decision stage in the innovation-decision process, the individual chooses to adopt or reject the innovation. While adoption refers to "full use of an innovation as the best course of action available," rejection means "not to adopt an innovation" (Rogers, 2003, p. 177). If an innovation has a partial trial basis, it is usually adopted more quickly, since most individuals first want to try the innovation in their own situation and then come to an adoption decision. The vicarious trial can speed up the innovation-decision process. However, rejection is possible in every stage of the innovation-decision process. Rogers expressed two types of rejection: *active rejection* and *passive rejection*. In an active rejection situation, an individual tries an innovation and thinks about adopting it, but later he or she decides not to adopt it. A *discontinuance* decision, which is to reject an innovation after adopting it earlier, may be considered as an active type of rejection. In a passive rejection (or non-adoption) position, the individual does not think about adopting the innovation at all. Rogers stated that these two types of rejection have not been distinguished and studied enough in past diffusion research. In some cases, the order of the knowledge-persuasion-decision stages can be knowledge-decision-persuasion. Especially in collectivistic cultures such as those in Eastern countries, this order takes place and group influence on adoption of an innovation can transform the personal innovation decision into a collective innovation decision (Rogers, 2003). In any case, however, the implementation stage follows the decision stage.

The Implementation Stage

At the implementation stage, an innovation is put into practice. However, an innovation brings the newness in which "some degree of uncertainty is involved in diffusion" (p. 6). Uncertainty about the outcomes of the innovation still can be a problem at this stage. Thus, the implementer may need technical assistance from change agents and others to reduce the degree of uncertainty about the consequences. Moreover, the innovation-decision process will end, since "the innovation loses its distinctive quality as the separate identity of the new idea disappears" (Rogers, 2003, p. 180).

Reinvention usually happens at the implementation stage, so it is an important part of this stage. Reinvention is "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). Also, Rogers (2003) explained the difference between invention and innovation. While "invention is the process by which a new idea is discovered or created," the adoption of an innovation is the process of using an existing idea" (Rogers, 2003, p. 181). Rogers further discussed that the more reinvention takes place, the more rapidly an innovation is adopted and becomes institutionalized. As innovations, computers are the tools that consist of many possible opportunities and applications, so computer technologies are more open to reinvention.

The Confirmation Stage

The innovation-decision already has been made, but at the confirmation stage the individual looks for support for his or her decision. According to Rogers (2003), this decision can be reversed if the individual is "exposed to conflicting messages about the innovation" (p. 189). However, the individual tends to stay away from these messages and seeks supportive messages that confirm his or her decision. Thus, attitudes become more crucial at the confirmation stage. Depending on the support for adoption of the innovation and the attitude of the individual, later adoption or discontinuance happens during this stage.

Discontinuance may occur during this stage in two ways. First, the individual rejects the innovation to adopt a better innovation replacing it. This type of discontinuance decision is called *replacement discontinuance*. The other type of discontinuance decision is *disenchantment discontinuance.* In the latter, the individual rejects the innovation because he or she is not satisfied with its performance. Another reason for this type of discontinuance decision may be that the innovation does not meet the needs of the individual. So, it does not provide a perceived relative advantage, which is the first attribute of innovations and affects the rate of adoption.

Attributes of Innovations and Rate of Adoption

Rogers (2003) described the innovation-diffusion process as "an uncertainty reduction process" (p. 232), and he proposes attributes of innovations that help to decrease uncertainty about the innovation. Attributes of innovations includes five characteristics of innovations: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability. Rogers (2003) stated that "individuals' perceptions of these characteristics predict the rate of adoption of innovations" (p. 219). Also, Rogers noted that although there is a lot of diffusion research on the characteristics of the adopter categories, there is a lack of research on the effects of the perceived characteristics of innovations on the rate of adoption.

Rogers (2003) defined the *rate of adoption* as "the relative speed with which an innovation is adopted by members of a social system" (p. 221). For instance, the number of individuals who adopted the innovation for a period of time can be measured as the rate of adoption of the innovation. The perceived attributes of an innovation are significant predictors of the rate of adoption. Rogers reported that 49-87% of the variance in the rate of adoption of innovations is explained by these five attributes. In addition to these attributes, the innovation-decision type (optional, collective, or authority), communication channels (mass media or interpersonal channels), social system (norms or network interconnectedness), and change agents may increase the predictability of the rate of adoption of innovations. For instance, personal and optional innovations usually are adopted faster than the innovations involving an organizational or collective innovation-decision. However, for Rogers, relative advantage is the strongest predictor of the rate of adoption of an innovation.

Relative Advantage

Rogers (2003) defined relative advantage as "the degree to which an innovation is perceived as being better than the idea it supersedes" (p. 229). The cost and social status motivation aspects of innovations are elements of relative advantage. For instance, while innovators, early adopters, and early majority are more status-motivated for adopting innovations, the late majority and laggards perceive status as less significant. Moreover, Rogers categorized innovations into two types: preventive and incremental (non-preventive) innovations. "A preventive innovation is a new idea that an individual adopts now in order to lower the probability of some unwanted future

event" (Rogers, 2003, p. 233). Preventive innovations usually have a slow rate of adoption so their relative advantage is highly uncertain. However, incremental innovations provide beneficial outcomes in a short period.

When faculty members face the new demands placed on them, they will adopt technology (Casmar, 2001). If teachers see that technology has value in their instruction, then they will use it (Finley, 2003; McKenzie, 2001; Parisot, 1995; Spotts, 1999). To integrate technology successfully into teacher education courses, teacher education faculty should see the need providing helpful experiences for themselves and their students (Schmidt, 1995).

To increase the rate of adopting innovations and to make relative advantage more effective, direct or indirect financial payment incentives may be used to support the individuals of a social system in adopting an innovation. Incentives are part of support and motivation factors. Another motivation factor in the diffusion process is the compatibility attribute.

Compatibility

In some diffusion research, relative advantage and compatibility were viewed as similar, although they are conceptually different. Rogers (2003) stated that "compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (p. 15). A lack of compatibility in IT with individual needs may negatively affect the individual's IT use (McKenzie, 2001; Sherry, 1997). In her literature review, Hoerup (2001) describes that each innovation influences teachers' opinions, beliefs, values, and views about teaching. If an innovation is compatible with an individual's needs, then uncertainty will decrease and the rate of adoption of the innovation will increase. Thus, even naming the innovation is an important part of compatibility. What the innovation is called should be meaningful to the potential adopter. What the innovation means also should be clear. This is part of the complexity attribute.

Complexity

Rogers (2003) defined complexity as "the degree to which an innovation is perceived as relatively difficult to understand and use" (p. 15). As Rogers stated, opposite to the other attributes, complexity is negatively correlated with the rate of adoption. Thus, excessive complexity of an innovation is an important obstacle in its adoption. A technological innovation might confront faculty members with the challenge of changing their teaching methodology to integrate the technological innovation into their instruction (Parisot, 1995), so it might have different levels of complexity. If hardware and software are user-friendly, then they might be adopted successfully for the delivery of course materials (Martin, 2003).

Trialability

According to Rogers (2003), "*trialability* is the degree to which an innovation may be experimented with on a limited basis" (p. 16). Also, trialability is positively correlated with the rate of adoption. The more an innovation is tried, the faster its adoption is. As discussed in the implementation stage of the innovation-decision process, reinvention may occur during the trial of the innovation. Then, the innovation may be changed or modified by the potential adopter. Increased reinvention may create faster adoption of the innovation. For the adoption of an innovation, another important factor is the vicarious trial, which is especially helpful for later adopters. However, Rogers stated that earlier adopters see the trialability attribute of innovations as more important than later adopters.

Observability

The last characteristic of innovations is observability. Rogers (2003) defined *observability as* "the degree to which the results of an innovation are visible to others" (p. 16). Role modeling (or peer observation) is the key motivational factor in the adoption and diffusion of technology (Parisot, 1997). Similar to relative advantage, compatibility, and trialability, observability also is positively correlated with the rate of adoption of an innovation.

In summary, Rogers (2003) argued that innovations offering more relative advantage, compatibility, simplicity, trialability, and observability will be adopted faster than other innovations. Rogers does caution, "getting a new idea adopted, even when is has obvious advantages, is difficult" (p. 1), so the availability of all of these variables of innovations speed up the innovation-diffusion process. Research showed that all these factors influenced faculty members' likelihood of adopting a new technology into their teaching (Anderson et al., 1998; Bennett, & Bennett, 2003; Parisot, 1997; Slyke, 1998; Surendra, 2001).

Adopter Categories

Rogers (2003) defined the adopter categories as "the classifications of members of a social system on the basis of innovativeness" (p. 22). This classification includes innovators, early adopters, early majority, late majority, and laggards. In each adopter category, individuals are similar in terms of their innovativeness: "Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system" (Rogers, 2003, p. 22). Braak (2001) described innovativeness as "a relatively-stable, socially-constructed, innovation-dependent characteristic that indicates an individual's willingness to change his or her familiar practices" (p. 144). For Rogers, innovativeness helped in understanding the desired and main behavior in the innovation-decision process. Thus, he categorizes the adopters based on innovativeness. As Figure 2.2 shows, the distribution of adopters is a normal distribution.

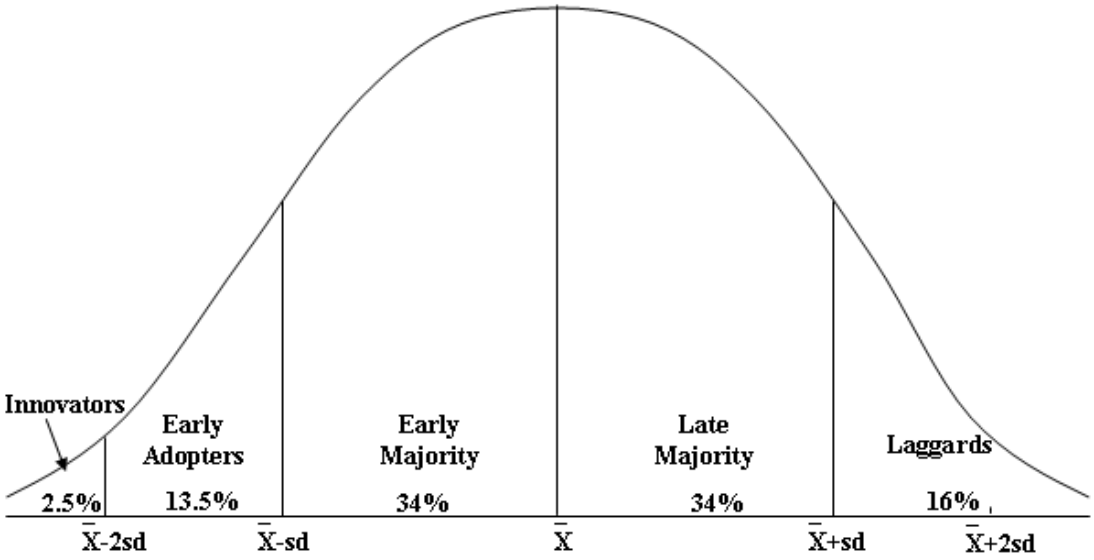

Figure 2.2. Adopter Categorization on the Basis of Innovativeness (Source: *Diffusion of Innovations, fifth edition* by Everett M. Rogers. Copyright (c) 2003 by The Free Press. Reprinted with permission of the Free Press: A Division of Simon & Schuster.)

Also, Rogers (2003) noted that incomplete adoption and non-adoption do not form this adopter classification. Only adopters of successful innovations generate this curve over time. In this normal distribution, each category is defined using a standardized percentage of respondents. For instance, the area lying under the left side of the curve and two standard deviations below the mean includes innovators who adopt an innovation as the first 2.5% of the individuals in a system.

Innovators

For Rogers (2003), innovators were willing to experience new ideas. Thus, they should be prepared to cope with unprofitable and unsuccessful innovations, and a certain level of uncertainty about the innovation. Also, Rogers added that innovators are the gatekeepers bringing the innovation in from outside of the system. They may not be respected by other members of the social system because of their venturesomeness and close relationships outside the social system. Their venturesomeness requires innovators to have complex technical knowledge.

Early Adopters

Compared to innovators, early adopters are more limited with the boundaries of the social system. Rogers (2003) argued that since early adopters are more likely to hold leadership roles in the social system, other members come to them to get advice or information about the innovation. In fact, "leaders play a central role at virtually every stage of the innovation process, from initiation to implementation, particularly in deploying the resources that carry innovation forward" (Light, 1998, p. 19). Thus, as role models, early adopters' attitudes toward innovations are more important. Their subjective evaluations about the innovation reach other members of the social system through the interpersonal networks. Early adopters' leadership in adopting the innovation decreases uncertainty about the innovation in the diffusion process. Finally, "early adopters put their stamp of approval on a new idea by adopting it" (Rogers, 2003, p. 283).

Early Majority
Rogers (2003) claimed that although the early majority have a good interaction with other members of the social system, they do not have the leadership role that early adopters have. However, their interpersonal networks are still important in the innovation-diffusion process. As Figure 2.2 shows, the early majority adopts the innovation just before the other half of their peers adopts it. As Rogers stated, they are deliberate in adopting an innovation and they are neither the first nor the last to adopt it. Thus, their innovation decision usually takes more time than it takes innovators and early adopters.

Late Majority
Similar to the early majority, the late majority includes one-third of all members of the social system who wait until most of their peers adopt the innovation. Although they are skeptical about the innovation and its outcomes, economic necessity and peer pressure may lead them to the adoption of the innovation. To reduce the uncertainty of the innovation, interpersonal networks of close peers should persuade the late majority to adopt it. Then, "the late majority feel that it is safe to adopt" (Rogers, 2003, p. 284).

Laggards
As Rogers (2003) stated, laggards have the traditional view and they are more skeptical about innovations and change agents than the late majority. As the most localized group of the social system, their interpersonal networks mainly consist of other members of the social system from the same category. Moreover, they do not have a leadership role. Because of the limited resources and the lack of awareness-knowledge of innovations, they first want to make sure that an innovation works before they adopt. Thus, laggards tend to decide after looking at whether the innovation is successfully adopted by other members of the social system in the past. Due to all these characteristics, laggards' innovation-decision period is relatively long.
In addition to these five categories of adopters, Rogers (2003) further described his five categories of adopters in two main groups: earlier adopters and later adopters. Earlier adopters consist of innovators, early adopters, and early majority, while late majority and laggards comprise later adopters. Rogers identifies the differences between these two groups in terms of socioeconomic status, personality variables, and communication behaviors, which usually are positively related to innovativeness. For instance, "the individuals or other units in a system who most need the benefits of a new idea (the less educated, less wealthy, and the like) are generally the last to adopt an innovation" (Rogers, 2003, p. 295). For Rogers, there was no significant difference between the ages of earlier adopters and later adopters, but this categorization and its characteristics are beyond this study.

Technology-Related Studies based on Rogers' Theory

Although many studies used Rogers' theory as their theoretical framework, few studies among them have considered computer use for instructional purposes (Isleem, 2003). The following studies are contextually related to instructional computer use.

Using quantitative research methods and Roger's diffusion theory, Isleem (2003) examined the level of computer use for instructional purposes by technology education teachers in Ohio public schools. Isleem studied the relationships between the level of computer use and selected factors: expertise, access, attitude, support, and teacher characteristics. Isleem discovered that technology education teachers use more mainstream computer applications than computer specialized applications. Moreover, Isleem found teachers' perceived expertise, perceived access to computers, and perceived attitude toward computers as the significant predictors of the level of computer use. In his study, Isleem emphasized that providing training is a main strategy to increase computer use.

Medlin (2001) used Rogers' (1995) diffusion of innovations theory to examine the selected factors that might influence a faculty member's motivation and decision to adopt new electronic technologies in classroom instruction. Medlin organized the findings into three groups: social, organizational, and personal motivational factors. As social factors, friends, mentors, peer support, and students were found to be the significant predictors that may influence a faculty member's decision to adopt electronic technologies in the classroom. The organizational variables, including physical resource support and mandates from the university, also were statistically significant in predicting the faculty members' use of electronic technologies in the classroom. "Personal interest in instructional technology," "personal interest in improvement in my teaching," and "personal interest in enhancing student learning" were cited as three personal motivational variables that might affect faculty members' decision to adopt instructional technologies. However, Medlin did not find a significant difference among the self-identified adopter behavior categories based on Rogers' theory in terms of social, organizational, and personal motivational factors.

Jacobsen (1998) used Rogers' (1995) diffusion theory to determine the adoption patterns and characteristics of faculty who integrate computer technology for teaching and learning in higher education. She used both qualitative and quantitative methods to analyze the characteristics of early adopters and the difference between early adopters and mainstream faculty. The selected factors investigated were patterns of computer use, computer expertise, generalized self-efficacy, participant information, teaching and learning changes, motivators to integrate technology for teaching and learning, impediments to integrating technology for teaching and learning, learning about technology, methods for using and integrating technology in teaching and learning, and evaluating the outcomes of using technology for teaching and learning.

Less' (2003) quantitative research study used Rogers' (1995) diffusion of innovations theory to investigate faculty adoption of computer technology for instruction in the North Carolina Community College System. She classified the faculty members based on Rogers' five categories of innovation adoption and compared them on the demographic variables of age, gender, race/ethnicity, teaching experience, and highest degree attained. While a significant relationship emerged between Rogers' adopter categories and their years of teaching experience and highest degree attained, the results did not show an important difference between faculty adopter categories and age, gender, and race/ethnicity. Less further classified the faculty as users in any of Rogers' five categories and non-users of computer technology in instruction. No significant difference existed between users and non-users in demographic characteristics of age, gender, race/ethnicity, teaching experience and highest degree attained.

Using Rogers' diffusion theory, Blankenship (1998) employed both qualitative and quantitative research methods in studying the factors that were related to computer use by instructors in teaching. In his study, the variables were attitude toward computers, access to computers, training in computer use, support for computer use, age, grade level taught, curriculum area, gender, and teaching expertise. All these factors were used to predict computer use by teachers in classroom instruction. One of the major findings of the study was that grade level and curriculum area must be considered for successful training. Also, attitude, support, access, and age were statistically significant predictors of computer use in classroom instruction. Finally, Blankenship suggested the following strategies to increase computer use in classroom instruction: grade and curriculum targeted computer training, technical support, and computer labs in every building.

Using quantitative research methods, Surendra (2001) examined the diffusion factors proposed by Rogers (1995) and other sources to predict the acceptance of Web technology by professors and administrators of a college. He reviewed the training factor among the types of access. Access in general and training in particular were found to be the best predictors in the diffusion process of Web technology-based educational innovation. Moreover, he found that the diffusion factors, Rogers' attributes of innovations, are useful predictors of the adoption of innovation. Also, a relationship was found between computer knowledge and the adoption of innovation.

Carter (1998) conducted a computer survey and in-depth interviews to determine computer-based technologies that were being used by the faculty members and the factors that affect their use of these technologies. Faculty attitudes toward using computer-based technology, support, resources, and training were the selected factors needed to use these technologies effectively. Also, Carter found that word processing software, e-mail, and Internet resources were the most frequently used computer-based technologies.

Another study was conducted by Zakaria (2001) on factors related to IT implementation in the curriculum. The selected factors in the study were the Malaysian Ministry of Education Polytechnic faculty members' attitudes toward IT, their IT use in teaching, and the availability of IT. Despite a lack of IT use in general, faculty members usually had a very positive attitude toward IT use in their teaching. Most faculty members reported barriers to IT use in their teaching. Furthermore, Zakaria argued there was a gender difference in terms of IT use. No significant difference existed between the faculty members' department membership and IT use in general. Also, he found that the highest level of education was negatively correlated with IT use and other demographic variables, and the level of education was correlated with email and World Wide Web use. While age was positively correlated with teaching experience, teaching load was significantly correlated with online discussion use. Finally, the highest level of education and adoption willingness were found to be the most significant predictors of IT use in teaching.

Analyzing the data quantitatively and qualitatively, Anderson et al. (1998) studied the attitudes, skills, and behaviors of the faculty members related to their IT use at a large Canadian research university. Based on Roger's (1995) two major adopter categories, they defined the faculty members as "earlier adopters" and "mainstream faculty" and provided strategies for reducing the gap between these two groups. Although mainstream faculty used information technologies for research and professional communication applications, their adoption of these applications in teaching was very low. To increase their adoption of computer

technologies for instructional purposes, the incentives, training programs, and barriers should be taken into account in comprehensive adoption strategies.

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