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Technology Adoption of Medical Faculty in Teaching: Differentiating Factors in Adopter Categories

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ABSTRACT

Despite large investments by higher education institutions in technology for faculty and student use, instructional technology is not being integrated into instruction in higher education institutions including medical education institutions. While the diffusion of instructional technologies has reached a saturation point among early adopters of technology, it has remained limited among the mainstream faculty. This investigation explores instructional technology usage patterns and the characteristics of medical school faculty as well as contributing factors to IT adoption. The focus of the study was to explore the differences between faculty members who have adopted new technology and those reluctant or resistant to IT adoption, and to determine whether faculty characteristics contribute to the prediction of faculty adopter categories. Faculties from the disciplines of basic and clinical science at a state university Faculty of Medicine were surveyed to gather data concerning faculty characteristics, adoption patterns, perceptions of computer-use self efficacy, the value of IT, barriers and incentives to adoption and preferences related to help and support in technology adoption. The data analysis was based on Rogers' theories of diffusion and adopter categories. Significant differences were found between early adopters and the mainstream faculty in terms of individual characteristics, adoption patterns, perceptions of barriers and technology learning preferences The results indicated that computer use self efficacy and rank significantly contribute to the prediction of faculty adopter group**.**

Keywords

Technology adoption, Diffusion of innovation, Adopter categories, Medical faculty technology use

Introduction

In the past few years, higher education institutions have invested heavily in infrastructure to support the diffusion and adoption of technology (Green, 1999; Jacobsen, 2000). However, despite large investments by higher education institutions in technology for faculty and student use, instructional technology is not being integrated into instruction in higher education institutions including medical education institutions (Geoghegan, 1994; Spotts, 1999; Surry, 1997; Albright, 1996; Carlile & Sefton, 1998). There are many reasons both technical and societal, explaining why innovative technologies have not been widely adopted, however, the major reason for this lack of utilization is that most university-level technology strategies ignore the central role that the faculty plays in the process of change (Surry & Land, 2000).

The Association for Educational Communications and Technology (AECT) has defined instructional technology (IT) as a complex, integrated process involving people, procedures, ideas, devices and organizations, for analyzing problems and devising, implementing, evaluating and managing solutions to those problems involved in all aspects of human learning (Seels & Richey, 1994). Despite the AECT definition of IT, in which the emphasis is on IT rather than its' products, many of the debates regarding the use of technology in education continues to focus on products: computers, software, networks and instructional resources (Green, 2000).

Certainly, the use of an adequate technology infrastructure is a prerequisite of IT integration, but the major challenge is to encourage the faculty to adopt these technologies once they are made available. Goeghegan (1994) expresses this challenge as follows:

> One of the most basic reasons underlying the limited use of instructional technology is our failure to recognize and deal with the social and psychological dimension of technological innovation and diffusion: the constellation of academic and professional goals, interest, and needs, technology interest, patterns of work, sources of support, social networks, etc., that play a determining role in faculty willingness to adopt and utilize technology in the classroom.

Adoption of or hesitation to adopt new instructional technologies by the faculty involves a complex system involving multiple variables. As stated by Spotts (1999), "…, the reality of instructional technology use is in the relationship between the new instructional technologies and the faculty members' individual and organizational context and their personal histories" (p. 93-94).

Diffusion of Innovations

Studies of diffusion and adoption help to explain the what, where, and why of technology acceptance or rejection in education (Holloway, 1996). Therefore, Rogers' (1995) theory of diffusion of innovations provides a theoretical framework for analyzing faculty technology adoption patterns.

Rogers (1995) defines an innovation as an idea, practice or object that is perceived to be "new" by the individual, and diffusion as the process through which an innovation is communicated through certain channels over time among the members of a social system. The innovation in the present investigation is represented by instructional technology, including computer-based tools and processes, and diffusion is represented by the extent to which the medical school faculty at a state university has adopted instructional technology in teaching and learning.

According to Rogers (1995), individuals in a social system do not adopt an innovation at the same time, a certain percentage of individuals are relatively earlier or later in adopting a new idea. Based on the *innovativeness* criterion that the degree to which an individual is relatively earlier in adopting new ideas than other members of a social system, the distribution of various adopter categories forms a normal, bell-shaped curve that illustrates Innovator (2.5%), Early Adopter (13.5%), Early Majority (34%), Late Majority (34%), and Laggards (16%) (Figure 1).

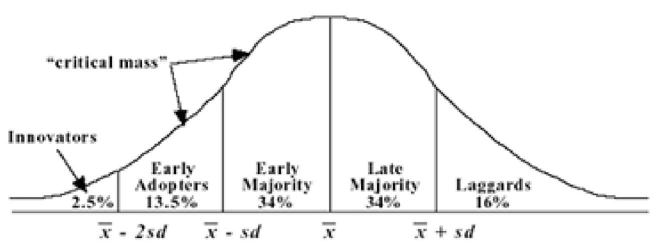

Figure 1. Adopter Categorization on the Basis of Innovativeness (Rogers, 1995)

Individuals who adopt an innovation at different points in diffusion process differ from one other in terms of social and psychological characteristics (Rogers, 1995). Those characteristics determine the individuals' willingness to adopt an innovation and their leadership functions. Some of the differences that have been cited separating early adopters from the mainstream include:

Early Adopters	Mainstream
➢ Favor revolutionary change	➢ Favor evolutionary change
➢ Visionary	➢ Conservative
➢ Strong technology focus	➢ Problem oriented
➢ Risk takers	➢ Risk Averters

➢ Experimenters ➢ Generally self-sufficient ➢ Horizontally connected	➢ Want proven applications ➢ May need significant support ➢ Vertically connected

The differences between people who fall into Rogers' Early Adopter and Early Majority categories create gaps in motivation, expectations and needs. The literature on individual characteristics of the faculty indicated that early adopters of instructional technology share common characteristics such as higher perceptions of efficacy and expertise (Anderson, Varnhagen & Campell, 1999; Jacobsen, 1998; Lichty, 2000; Oates, 2001), risk taking and experimentation (Oates, 2001), positive attitude toward technology (Spott, 1999) and personal interest in technology (Oates, 2001).

As stated by Bates (2000), "because of the central role that faculty members play in the work of the universities and colleges, any change, especially in core activities such as teaching and research, is completely dependent on their support" (p.95). Therefore, in order for large-scale technology adoption and diffusion to happen, it is critical to understand and bridge differentiated needs and expectations of faculty members (Garofoli & Woodell, 2003). Thus, the purpose of the present study is to explore the differences between faculty members who are open to, and those who are reluctant or resistant to IT adoption, and to determine if faculty characteristics contribute to the prediction of faculty adopter categories. Rogers' (1995) theories of diffusion of innovations were used to analyze the differences in the IT adoption of the medical school faculty.

Method

The present investigation surveyed faculty members from basic and clinical science disciplines at a faculty of medicine at a state university in Turkey. Information was gathered about technology use patterns, computer experience and use of technology for teaching, perceived computer use self efficacy, perceived value of IT, perceived incentives, and barriers. Survey items were adopted or selected from previous investigations of faculty adoption patterns (Anderson, Varnhagen, & Campbell, 1999; Jacobsen, 1998) and Microcomputer Utilization in Teaching Self-Efficacy Beliefs Scale (Enochs, Riggs, & Ellis, 1993).

The survey was distributed to 305 faculty members and complete data was obtained from 155 (50.3%) participants (72.7% male and 27.3% female), holding various academic ranks (i.e. 32.7% professors, 19.6% Assoc. Professors, 22.1% Asst. Professor and 25.6% others) having an average of 10 years of teaching experience. While the average age was 41 years, the largest group (≈55%) was in the 31-40 age groups. The majority of the respondents (76.8%) were instructors of clinical science.

Adopter Groups

In order to classify respondents into adopter categories (early adopters (EA), mainstream faculty (MF)), the individual innovativeness scoring procedure developed by Anderson, Varnhagen and Campbell, 1999 was used. The scoring procedure was developed on the basis of the assumption that EAs have come to use these technologies earlier and have gained more expertise relatively to majority faculty (Anderson, Varnhagen, and Campbell, 1999). A composite score was calculated for innovativeness of faculty by adding the self_rated expertise level of each individual faculty member (i.e., 1 for Extensive, 2 for Good, 3 for Fair, 4 for Novice, 5 for None) indicated for each of the 11 types of computer software and tools The total possible range for cumulative score for innovativeness is 11-55; the sample scores ranged from 13 to 51. Consistent with Rogers' assertion that adoption of an innovation will be normally distributed, cumulative frequency of the scores on this scale approach an S-shaped curve which lends confidence to assumption of normalcy.

By using Rogers' (1995) adopter categories and innovativeness scores, 16% (n=25) of the respondents were assigned to the Early Adopter group (EA) (2.5% Innovators+13.5% Early Adopters =16% EA), and 84% (n=130) of the respondents were assigned to the Mainstream Faculty (MF) group(34% Early Majority+34% Late Majority+ 16% Laggards=84%MF) (Figure 2).

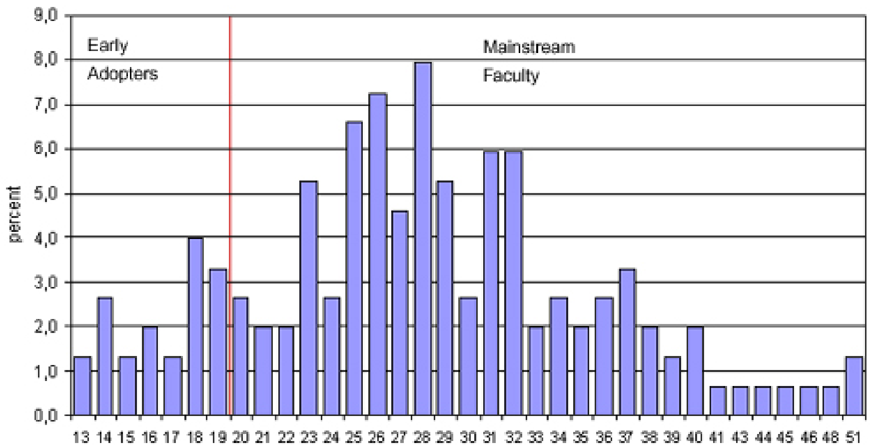

Figure 2. Distribution of Faculty Innovativeness Scores

Results

The EA group is more likely to consist of junior assistant professors ($\chi 2(1, 155)=5.59$, $p=0.019$), in the 20-40 age interval ($\chi 2(1, 25)=4.840$, $p=0.028$).

Although there are no significant differences between adopter groups in terms of computer ownership and internet access at home and in the office, the EA group uses computers more often($\chi 2(1, 146)=11.34$, $p=0.001$) .

Technologies Used in Teaching

Participants were asked to indicate which of the 12 instructional technologies they use in the teaching-learning process. Early adopters significantly have used more technologies than Mainstream Faculty group ($t(151)=2.841$, $p<0.05$ Ms 5.58 vs. 4.38), and it is likely that they have used course web pages (Pearson $\chi 2(1, 153)=8.306$, $p=0{,}009$), web resources ($\chi 2(1, 153)=7.018$, $p=0.018$) and commercial educational software ($\chi 2(1, 153)=22.077$, $p=0.000$) more than the Mainstream faculty. The proportion of technologies used by the adopter group is presented in Table 1. These findings indicate that relatively new instructional technologies have diffused into the early adopter group more than the mainstream faculty.

Table 1. Adopter Groups' Technology Use

	Early Adopters %	*Mainstream Faculty* %
Blackboard	62.5	67.4
Overhead	75.0	69.8
Slide Projector	75.0	76.7
Computer + Projection	100.0	94.6
Video	25.0	19.4
Sound	8.3	3.1
Special Laboratory	29.2	20.9
Course web sites	33.3	10.9
Web resources as a part of content	37.5	14.7
Commercial educational software	16.7	0.0
Word processors for course materials	45.8	31.0
Presentation software	50.0	29.5

Computer Use Self-Efficacy

Computer use self-efficacy is defined as an individual's belief regarding their ability to use computer competently (Compeau & Higgins, 1995). Previous research provides evidence that perceived efficacy regarding computer use is a significant factor in an individual's adoption decision (Lichty, 2000; Marcinkiewicz, 1994; Compeau & Higgins, 1995).

In order to assess faculty self-efficacy in computer use in teaching, the 10-item "Microcomputer Utilization in Teaching Efficacy Belief Scale" developed by Enochs, Riggs and Ellis (1993) and used in previous research (Lichty, 2000) was used. Respondents were presented with a five-point scale (i.e. 5 for Strongly Agree, 4 for Agree, 3 for Neutral, 2 for Disagree, 1 for Strongly Disagree) to indicate their level of agreement with each statement about computer use. Internal consistency of this subscale yielded a coefficient alpha of .91. As expected, EAs had significantly higher level competency of computer use than the MF group ($t(144)=6.263$, $p<0.01$ Ms 44.68 vs. 37.38)

Perceived Value of IT

"The individual's attitudes or beliefs about the innovation have much to say about his or her passage in the innovation-knowledge process" (Rogers, 1995, p.167). To adopt an innovation, the individual must define the innovation as relevant and useful in a specific situation. In order to gather data about faculty perception of the value of IT in medical education, participants were asked to indicate their level of agreement on 10 items regarding value of IT using five-point scale (i.e. 1 for Strongly Agree, 2 for Agree, 3 for Neutral, 4 for Disagree, 5 for Strongly Disagree). Although IT use in medical education is perceived to be valuable by the majority of the faculty (Mean=11.75, SD = 3.4), EAs valued IT more than MFs significantly ($t(151)= -2 .681$, $p<0.01$, Ms 10.12 vs. 12.07). The EA group had statistically stronger beliefs than the MF group that technology enables instructors addressing different learning styles, using time effectively and increasing their productivity (Table 2).

Table 2. Significant Differences between Adopter Groups on the Perceived Value of IT

Items	t	df	p	Means
Technology enables me to address the different learning styles of students.	-3.055	153	0.003	1.24 vs. 1.64
Using technology enables me to use lecture time efficiently	-2.357	153	0.020	1.28 vs. 1.61
Using technology increases my productivity as an instructor	-2.357	153	0.020	1.28 vs. 1.61

Perceived Barriers

In explaining the limited adoption of instructional technology among faculty members, Jacobsen (2000) states that "the explanation for limited adoption may be found in the many barriers that still constrain use by enthusiastic beginners" (p.2).

Table 3. Percentages of Agreement on Barrier Items Scale of Adopter Groups

Barrier Items	***Early Adopters***	***Mainstream Faculty***
	%	**%**
Lack of computers for faculty members.	66.7	54.3***
Lack of printers and/or other peripherals needed to effectively use computers for teaching and learning.	72.0	60.0***
Lack of computers for students	68.0	68.0***
Lack of support for supervising student computer use.	80.0	66.1***
No reward structure that recognizes faculty members for using technology in teaching and learning.	66.7	67.2***
Inadequate financial support for the integration of instructional technology.	54.2*	37.3
Lack or inadequacy of training opportunities for faculty members to acquire new computer knowledge and skills.	44.0	51.9**

*** rated agree or strongly agree by over 50% of the both adopter groups
*rated agree or strongly agree by over 50% of EA
** rated agree or strongly agree by over 50% of MF

Participants were presented with a five-point scale (i.e., 1 for Strongly Agree, 2 for Agree, 3 for Neutral, 4 for Disagree, 5 for Strongly Disagree) to indicate the level of their agreement with 20 barrier related items. An estimate of the internal consistency of this subscale yielded a coefficient alpha of .86, which indicates that the faculty responded consistently across the items.

Over 50% of both adopter groups agreed or strongly agreed that the lack of computers for individual faculty and students, the lack of computer peripherals, the reward structure and the lack of support service for students were barriers to the integration of technology into medical education. In addition to these barriers, 54.2 % of the EA group agreed or strongly agreed that inadequate financial support was a barrier and 51.9% of the MF group agreed or strongly agreed that the lack of training opportunities was an impediment to technology integration (Table 3).

Although the adopter groups gave similar responses, the EA and MF groups had exhibited significant differences in their perceptions about barriers to adoption (Table 4). Because the EA group has a relatively higher level of technological knowledge and skills, and interest in technology use, as expected, the EA group rated knowledge and skills barrier lower than the MF group. The EAs also disagreed highly than the MF group about the statements that software and IT are unsuitable for their instructional needs. The EA group expressed a higher level of agreement than the MF group regarding faculty members' interest in using technology for instruction.

Table 4. Significant Differences Between Adopter Groups' Perceptions About Barriers

Items	t	df	p	Means
I have lack of necessary knowledge and skills for using technology effectively.	6,74	152	p < .001	4,64 vs.3,28
Available software doesn't fit to my instructional needs.	2,92	149	p < .05	4,24 vs. 3,75
Instructional technologies do not fit the course or curriculum that I teach.	3,55	152	p < .05	4,48 vs.3,95
Faculty members are not interested in using technology for instruction.	-2,43	151	p < .05	3,00 vs. 3,52

Perceived Incentives

The participants were presented with a five-point scale (i.e., 1 for Very Important, 2 for Important, 3 for Neutral, 4 for Not Important, 5 for Not Important At All) to rate the level of importance of various statements on incentives for adoption. Over 90% of both adopter groups rated that among university policy and plans for diffusion of IT, investments in infrastructure, training and support and financial support are very important incentives for IT adoption. Reward structures and the reduction of teaching loads also were rated as important incentives by over 60% of both groups.

Preferred Methods of Learning Concerning Technology and Support

In many research studies, resources for training and support were identified as important incentives to faculty adoption of technology for teaching (Anderson, Varnhagen & Campbell, 1999; Green, 1999). Jacobsen (1998) suggest that "Individuals tend to have preferred methods for learning more about technology (p.96). In terms of methods for acquiring knowledge and skills about technology and support respondents rated their level of preferences on 12 items using a five -point scale (i.e., 1 for Strongly Prefer, 2 for Prefer, 3 for Neutral, 4 for Don't Prefer, 5 for Don't Prefer at All).

Over 90% of the both adopter groups rated online resources and printed materials as strongly preferred methods. Because EAs have a higher level of expertise in technological resources, not surprisingly, EAs preferred online resources more strongly (t(153)=-2.726, p<0.01 (Ms 1.24 vs. 1.64)) than MFs. While the EA group preferred or strongly preferred workshops and presentations (84%), structured in service training (79.2%) and experimenting alone (68%), MFs preferred structured in service training (88.3%), workshops and presentation (82.5%) and experimenting alone (58.4%) in descending order.

Participants' preferences of help and support are given in Table 5. Consistent with the Rogers'(1995) assertion that early adopters' interpersonal networks are more likely to be outside, EAs preferred colleagues at another institution (t(146)=-2.807, p<0.01 (Ms 2.04 vs. 2.69)) and outside professionals (t(148)=-2.851, p<0.01 (Ms 2.08 vs. 2.71)) significantly stronger than MFs.

Table 5. Preferred Methods of Support By Adopter Groups

Items	Early Adopters %	Mainstream Faculty %
Experienced graduate students	95.8	84.6
Colleagues on campus	96.0	90.6
Colleagues at another institution	72.0	50.4
Outside professionals	80.0	48.0
Support service	87.5	90.4
Hot-line, or telephone assistance	50.0	58.1
One on one help	79.2	89.5

Relationships between Faculty Characteristics and the Adopter Categories

Logistic Regression analysis was conducted to determine whether a set of faculty characteristics (rank, sex, age, discipline, teaching experience, self-efficacy, perceived value of IT) contribute significantly to prediction of faculty members' adopter categories. More than 30% of the variation in the Adopter Group variable explained by the Logistic Regression model (Cox&Snell R2=0.307, Nagelkerke R2=0.520). Results of the stepwise logistic regression analysis indicated that among the most powerful predictors of faculty adopter groups are rank and computer use self-efficacy (Table 6). This model shows that faculty members whose ranks are lower than professor and, faculty members whose self-efficacy beliefs are higher are more likely to be an Early Adopter.

Table 6. Results of Stepwise Logistic Regression

Variable	Beta	S.E.	z.stat	Wald	p	Exp(B)
Rank	-2.390*	.930	2.57	6.609	0.010	0.092[a]
Computer-use Self Efficacy	-.375	.080	-4.68	21.769	0.000	0.687[b]
Constant	21.57					
Model Chi-square=78.216, df=2, p<0.001 Cox&Snell R^2=0.285, Nagelkerke R^2=0.483						

Note:*Significant at the .05 level.
[a] Odds ratio associated with one unit increase in rank
[b] Odds ratio associated with one unit increase in computer use self-efficacy

The model explained more than 28% of the variation in the Adopter Group variable and was able correctly to classify 47.8% of early adopters and 96.6% of mainstream faculty, for an overall success rate of 88.7%.

Discussion

The findings of this study provided additional evidence that early adopter and mainstream faculty have different characteristics and different needs in technology integration. As suggested by Jacobsen (1998), understanding the differences between early adopter faculty and mainstream faculty will help us build programs and encourage faculty members to pursue the adoption of instructional technology.

Identifying the differences between early adopters and the mainstream faculty leads to the understanding that different approaches are needed to bridge the gap between EA and MF groups in the diffusion of instructional technology and to encourage EAs for their efforts. It is obvious that faculty support programs designed with a "one-fit-all" approach fail to succeed.

The results of this study indicate that the early adopter faculty and the mainstream faculty in this study have different needs in training and support. It seems that formal training programs do not appeal to early adopter faculty members who have a level of expertise in technology use. In designing training programs, institutions might consider gearing early adopters towards advanced topics and focusing on the specific needs of these faculty members. By providing incentives such as release time for training, providing funds for developing instructional materials, supporting symposia and conference participation, EAs must be motivated to continue their focus on innovation, the re-invention of technology and to share their expertise with the mainstream. Making innovative faculty members aware of each other and encouraging them to share resources and expertise could be an effective way of increasing motivation and sustaining growth (Surry & Land, 2000).

The literature and the results of this study suggest that computer use self-efficacy belief of individuals is a significant factor in their utilization of technology. From the standpoint of the self-efficacy theory, the ideal method for developing teachers' self-efficacy for computer use would be to provide them with training and support to work successfully with technology (Albion, 1999). In designing training and support programs, institutions might consider a number of strategies that address self-efficacy perceptions of the mainstream faculty members. Besides providing training opportunities, building comprehensive and systematic technology support systems is essential to increasing the faculty member’s confidence with the use of technology in teaching and learning.

Faculty development seemed to work best when the institution had a culture pervaded by the use of technology and supported by a wide range of strategies (Bates, 2000). One of these strategies is an extensive investment in infrastructure. Although ownership of computers for professional/home use is almost completely diffused among the faculty in this study, most faculty members were dissatisfied with the current investment in technology and distribution of available resources among departments. Therefore, to encourage the adoption and diffusion of technology, the institutions’ investment in technology should be based on a long range technology plan driven by the institutions’ overall vision and strategy for its teaching.

Similar to most higher education institutions, research publications are the predominant or even the only criterion for appointment, tenure and promotion in medical institutions. Medical school faculty members, especially young faculty members who have carrier concerns are unwilling to spend time and effort to develop technology-based applications for teaching, although they are more familiar with technology than their senior professors. The results from this study also indicate that the lack of a reward system that recognizes faculty efforts in technology use for teaching is an impediment for wide-spread diffusion of instructional technologies. Therefore, to motivate faculty members in technology use, intuitions should develop reward and incentive systems that are linked to technology use in teaching and learning such as release time, funding to support the development of technology materials and considering instructional activities in the promotion process.

Recommendations for Higher Education Institutions

Higher education institutions today are confronted with instructional technology innovation, which is transforming the way in which faculty and students interact and the roles they take. If the goal of the higher education institution is the integration of technology for a transformative change, then rather than the acquisition of technology itself, there must be a clear focus on the faculty members who use technology. For large-scale technology integration to occur in teaching, it is essential to understand and address differentiating needs of faculty in faculty development and support systems.

The following suggestions are offered to higher education institutions to improve their faculty members’ IT adoption for teaching and diffusion of instructional technology in medical education:

1. Develop a long-range technology plan driven by the institutions’ overall vision and strategy for its teaching.
2. Establish a promotion system that places a high value on teaching and the use of innovative teaching methods.
3. Design faculty development programs considering the needs of different faculty member profiles.
4. Provide training programs not only on the technical aspects of technology, but also about the integration of technology for teaching and learning.
5. Establish an instructional technology center in which faculty members can get help from and work together with IT related professionals.
6. Provide systematic technical and professional support.

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