Does the Extended Technology Acceptance Model Apply to Physicians

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ABSTRACT

In previous studies, the technology acceptance model (TAM) [1] has been widely used by information technology researchers to gain a better understanding of information technology (IT) adoption and its use in organizations. While TAM has been applied and tested in academic and corporate settings, involving students, business managers, clerical and administrative types as subjects, few studies have evaluated TAM in the health care environment.

This study examines the applicability of the extended Technology Acceptance Model (TAM2) [2] in the context of physicians' intention to adopt Internet-based health applications.

Data were collected in a survey of pediatricians to see how well the extended model, fits in the medical sector. Our results partially confirm the model, however significant theoretical aspects were not supported. One of the core perception variables, perceived ease of use, did not predict intention to use in this study. As theorized, the primary predictor variable perceived usefulness was a strong determinant of intention to use. This paper discusses the implications, limitations, and possible explanations for the inconsistencies within the model when applied to such professional users as physicians.

INTRODUCTION

Information technology has become pervasive in the healthcare industry. Many view information technology innovations specifically, the Internet as a strategic healthcare tool. The Medical Records Institute [3] suggests that Internet-based health applications (IHA), for example, electronic health records, e-prescribing, and mobile health are the goals of most healthcare organizations. Others contend that the use of the Internet for electronic medical records, e-billing and patient schedule can enable the health care industry to reduce its inefficiencies and errors in the care delivery processes (HIMSS/IBM Leadership Survey, 2000) [4]. While the use of IT in healthcare has increased tremendously, key players, particularly physicians still have not fully embraced the valuable resource of the Internet.

Despite the purported advantages of IT investments in healthcare many doctors do not widely use Internet-based health applications in their clinical practices. Physicians often misunderstand the functions and full potential of the Internet [5].

To address this issue we utilized TAM2 to examine physicians' intention toward the adoption of Internet-based health applications. TAM has been well tested and proven to be quite reliable and robust in predicting user acceptance in business related studies. TAM and TAM2 both posit that an individual's intention to use a system is determined by two primary belief factors: *perceived usefulness* and *perceived ease of use*. Davis asserted that perceived usefulness is the degree to which a person believes that a particular information technology would enhance his or her job performance. Perceived ease of use is the degree to which a person believes that using a particular innovation would be free of effort [1]. TAM2 however, incorporates two additional theoretical constructs: *cognitive instrumental processes* and *social influence processes*. Four cognitive factors influence perceived usefulness: job relevance, output quality, result demonstrability, and perceived ease of use. Three social

forces influence perceived usefulness: subjective norm, image, and voluntariness. (See Figure 1)

As described by Venkatesh and Davis, job relevance is an

telemedicine technology, following a theory comparison approach. The study evaluated the extent to which the technology acceptance model, the theory of planned behavior (TPB) and an integrated model using both TAM

Figure 1: Extended TAM Model (TAM2)
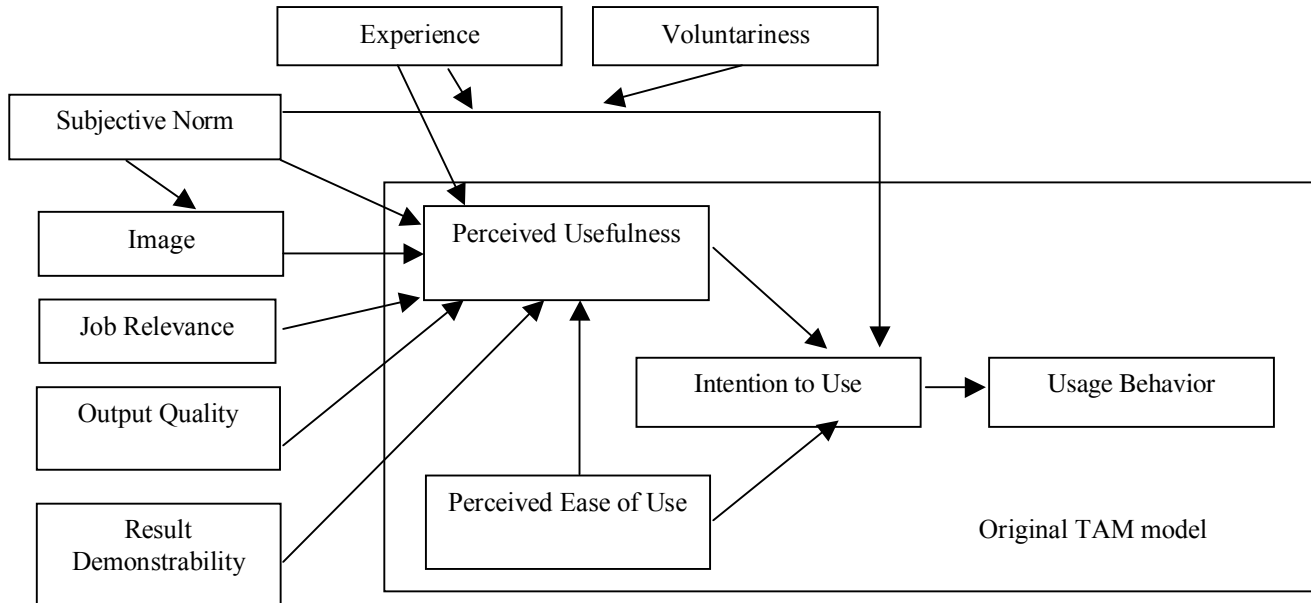
individual's perception of the degree to which the technology is applicable to his or her job. Output quality is an individual's perception of how well a system performs tasks necessary to his or her job. Result demonstrability is the tangibility of the results of using the technology. Perceived ease of use both directly and indirectly impacts on perceived usefulness. Subjective norm is defined as a person's perception that people who are important to her think she should or should not use the technology.

Image is the degree to which one perceives the use of the technology as a means of enhancing one's status within a social group. Finally, voluntariness is the extent to which one perceives the adoption decision as non-mandatory [2].

TAM has been tested across a number of industries and technologies, but only four published studies relate to healthcare. Hu, Chau and Tam [6] investigated physician acceptance of telemedicine technology and found evidence that TAM does not fit well with physicians. A significantly modified version of the original TAM model has been tested for IT adoption by family physicians [7], but did not include the enhancements from TAM2. Chau and Hu [8] examined physicians' acceptance of

and TPB could explain individual physicians' technology acceptance decisions. The findings suggested that TAM was more appropriate than TPB and the integrated model for examining technology acceptance by individual professionals. To date TAM2 has not been tested in the healthcare arena, with the exception of this research.

In this study, we test the applicability of the TAM2 model in the healthcare setting, specifically within pediatrics. The growing importance of the Internet for physicians [3], lead us to investigate the adoption of the Internet and Internet-based health applications (IHA) within the field of pediatric. Our goal is help address the needs of the pediatric and medical
community as a whole in applying information technology [9].

METHODOLOGY

To evaluate TAM2, modifications were made to the original questionnaire to better fit the physician community. The construct "voluntariness" was omitted because use of the Internet and IHA was not being mandated, nor was there any expectation that it would be mandated in the foreseeable future.

Similarly, the construct "experience" is intended to be used for studies after subjects have worked with a system. TAM2 hypothesized a decrease in the strength with which social influence processes affect perceived usefulness and intention to use with increasing experience with a technology over time ([2], p. 192-93). Since we were not testing a particular system or IT, we omitted the experience construct as well.

The TAM2 questionnaire was adapted and tailored to be more specific to pediatricians. The modifications were based on the findings of a physician-centered focus group and pretest procedures. Changes made to the original questionnaire to assure face and content validity for the context of this study consisted of:

1) Exclusion of such variables as voluntariness, experience and usage behavior because we were not testing an actual technology or system; therefore voluntariness versus mandatory, experience and self-reported usage were not applicable to this study.

2) The inclusion of two additional questions to the output quality variable based on information ascertain from the physician-based focus group. Concerns of output quality regarding Internet-based health applications were pressing among pediatricians in the focus group.

3) Rewording of all sentences to incorporate the nomenclature of and the word pediatrician(s) to questions where applicable. This change was based on feedback from the pretest and pilot study, in order to increase interest by providing personal and professional appeal and thus enhance response rate.

4) Substituting the word "system" with IHA for Internet-based health applications or the Internet.

5) Changing the verb tense of some sentences to future tense rather than present tense. For example, the perceived usefulness and perceived ease of use variables make assumptions that subjects have some experience with the technology in question. Discussions with physicians and the author of TAM assured us that it was appropriate to change the verb tense for the pretest because usefulness and ease of use is speculative [10].

6) Reduction of the Likert-type scale from a 7-point to a 5-point Likert-type scale, where (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). This reduction was made based on suggestions made during the focus group and pilot test.

7) Items were randomly sequenced on the questionnaire to reduce potential ceiling or floor effect that induces monotonous responses to items designed to measure a particular construct.

The full list of questions and their associated constructs is in the appendix.

The TAM2 questions were included in an eight-page survey with sections on the current use of computer and Internet-based technologies, anticipated future use of the Internet, barriers to the use of Internet-based health applications, attitudes toward the technologies, and open-ended questions allowing respondents to express their views. As this paper is a part of a larger study designed to understand physicians' attitudes toward and intentions to adopt IHA, we only discuss here the applicability of TAM2 in predicting physicians' intention. (A complete copy of the survey is available from the authors.)

Although the TAM scales have been validated by much prior research, the modified instrument was examined for reliability within the context of pediatricians. Reliability was examined using the Cronbach's alpha values. As summarized in Table 1, all of the values were above 0.70 the acceptable range recommended by the literature and most were above the 0.80, which is considered very good [11].

Table 1. Reliability of Scale Measures

Construct	Cronbach's Alpha
Perceived Usefulness	.86
Perceived Ease of Use	.85
Intention to Use	.83
Subjective Norm	.86
Image	.92
Job Relevance	.75
Output Quality	.86
Result Demonstrability	.72

Factor analysis was then conducted to examine convergent and discriminant validity. We specifically, performed the maximum likelihood method analysis with a promax rotation, because of the probable correlation between or among the factors examined. As shown in Table 2, five factors were extracted with an egienvalue > 1.0.

Convergent validity is considered to be satisfactory when items load high on their respective construct or factor. Most of the items exhibited a loading higher than 0.50 on

their respective factors, with the exceptions of result demonstrability, with a loading of 0.30, perceived ease of use (0.40) and job relevance (0.45). In spite of the loading of these items, desirable convergent validity was achieved.

Table 2. Component Extraction and Total Variance

	Initial Eigenvalues			
	Total	% of Variance	Cumulative %	Total
Component				
1	**10.067**	**43.768**	**43.768**	8.319
2	**2.503**	**10.883**	**54.651**	7.014
3	**2.067**	**8.985**	**65.636**	4.974
4	**1.558**	**6.774**	**70.409**	5.114
5	**1.001**	**4.350**	**74.760**	4.066

Discriminant validity was evaluated by examining whether each item loaded higher on the construct it measured than on any other construct. Table 3 summarizes the results suggesting that the measurement exhibited somewhat reasonable discriminant validity for the context of this study. However, the factor loadings are not considered as clean or consistent with factor analysis results reported in previous studies [1, 2, 6, 9]. Because our constructs had been chosen a priori (based on theory instead of experience) we did not need to, 1) interpret the meaning of the variable or, 2) give a descriptive name to the factors. The identification of the variables and labeling of factors had been completed by the investigators in prior studies [1-2].

Understanding the composition of the TAM2 theory it is not difficult to see why job relevance and intention to use loaded on the perceived usefulness construct. Result demonstrability, which is the tangibility of the results of using a technology loaded on the perceived ease of use construct. Notice also that two variables - job relevance (2) and perceived ease of use (1) are listed on factors 1 and 2 due to their moderate loadings on both. Again, because the constructs were chosen a priori we applied them according to the literature [2].

To address our research question regarding the applicability of TAM2 for pediatricians we performed separate regression analyses with intention to use (ITU)

and perceived usefulness (PU) as the criterion variables all other variables were entered as predictor variables. The results are presented in the following section.

Table 3. Component Factor Loading

	1	2	3	4	5
PU1	.833				
PU2	.749				
PU3	.917				
PU4	.775				
ITU1	.728				
ITU2	.929				
JR1	.574				
JR2	.459	.461*			
IMG1			.838		
IMG2			1.012		
IMG3			.876		
SN1					.693
SN2					.950
OPQ1				.798	
OPQ2				.987	
OPQ3				.641	
OPQ4				.519	
PEOU1	.494*	.404			
PEOU2		.756			
PEOU3		.896			
PEOU4		.890			
RD1		.589			
RD2		.300			

RESULTS

The study targeted practicing pediatricians in Hawaii. Of the two hundred and five questionnaire packets mailed, eighty-nine were returned completed and deemed usable. This yielded an effective response rate of 43%. Among the respondents, 58% were males and 42% females. Almost half of the respondents work in a solo practice and seventy-one percent work in a practice with ten or fewer physicians. These figures are comparable to US figures as reported by the American Academy of Pediatrics in its survey of members [12] with the exception of practice size. The national average of solo pediatric practices is only 10.6%.

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TAM2 Regression Results

Regression analyses were used to explain intention toward usage (ITU) also referred to as behavioral intention. Consistent with prior research [1, 2, 6-8], perceived usefulness (B = .660, p <. 000) was a strong determinant of intention to use. The effects of perceived usefulness and output quality explained 59% of the variance of usage intentions by pediatricians. While perceived usefulness had a significant effect on intention to use, perceived ease of use and the social processes of subjective norm and image did not.

Stepwise regression analyses were performed for perceived usefulness, as it is the determinant variable posited by the literature. To explain perceived usefulness, we performed multiple regression analysis with perceived usefulness as the criterion or dependent variable and all of the remaining variables, with the exception of intention to use as possible predictor or independent variables. TAM2 explained up to 59% of variance in perceived usefulness. The factor determining perceived usefulness was job relevance (B=.775, p < .000). Again, perceived ease of use and the social influence processes were not significant at the 0.05 level in this model. Figure 2 shows these results.

adequate and applicable in the professional context of physicians.

As theorized perceived usefulness was found to have a significant and strong influence on physicians' usage intention. However, perceived ease of use, one of TAM's core constructs was not significant. These findings are not consistent with prior studies that have not used physicians as the targeted subjects [1, 2, 14], however our results are similar to those studies that did use professionals as their test bed [6, 8, 13]. Consistent with Hu et al [6] who evaluated TAM examining physicians' acceptance of telemedicine, ease of use was found to have no significant influence on attitude and perceived usefulness. Chau et al [8], also examining physicians' acceptance of telemedicine reported that perceived usefulness was the most significant factor affecting physicians' acceptance of telemedicine technology, while perceived ease of use had no significant effect on either perceived usefulness or attitude.

Jayasuriya evaluated TAM in the professional context of nurses [13]. The results showed that computer acceptance and use by nurses would be affected by their perception of the computer's usefulness than by the training provided. They concluded that the most important factor that

Figure 2: Results of Regression Analyses (Significant relationships at p< .05)
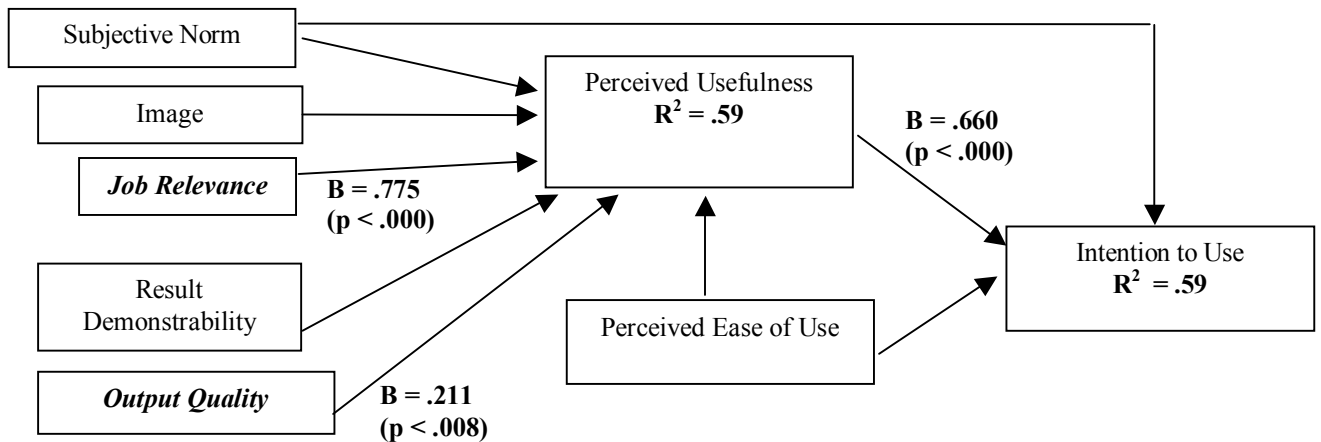
DISCUSSION

The understanding of factors that influence physicians' intention to adopt Internet-based health applications is important as the Internet becomes increasingly more useful and common place in the health care setting. This study examined the applicability of TAM2 for predicting physicians, specifically, pediatricians' intention to adopt IHA. The results suggest that TAM2 was partially

determines the use of computer technology for work in the case of health care professionals (especially nurses) would be their perceived usefulness and the level of skill they acquire of the computer applications 1998, pp.192-193).

Hu et al [6] explained that physicians on the average have a higher level of competence, intellectual and cognitive capacity, adaptability to new technologies and reliable

access to assistance in operating technology. Physicians are considerably different from the students, administrative staff, knowledge workers, and system developers typically examined in previous TAM studies. For these reasons the variables of perceived ease of use may not be sufficient or perceived as critical with this professional user group.

Chau et al [8] explained that physicians tended to be more pragmatic in their acceptance of telemedicine technology. Physicians, unlike non-professionals focused on the usefulness of the technology, rather than the ease of using it. Keil et al [15] reports that in determining whether or not to use a technology, usefulness is more important than ease of use. In our context, an important factor for pediatricians' intention to adopt IHA was whether the technology was useful, relevant and the output quality was sufficient for their completion of daily tasks. Chau et al suggests that physicians have relatively strong staff support for operating medical equipment and related technologies [8] as well as a relatively high competence capacity, which allows them to comprehend new technologies quicker than the average population. Also, physicians are willing to adopt beneficial applications of information technology even if they may not be easy to use. These factors could account for the lack of weight placed perceived ease of use. Keil et al [15] explained that "no amount of ease of use will compensate for low usefulness". Perceived ease of use was measured in this study, and contrary to several previous studies - did not have a significant effect on behavioral intention or perceived usefulness.

With this in mind, our study suggests that pediatricians are willing to adopt and use Internet-based health applications if those applications are perceived as beneficial in helping the physician in the performance their daily jobs. Usefulness is operationalized as increasing the pediatricians' productivity, improving their quality of care, enhancing their effectiveness and providing overall practical service. Two of the three cognitive instrumental determinants of perceived usefulness, job relevance and output quality, theorized in TAM2 were significant in this study. Again, the results emphasize the pragmatic perceptions that physicians have toward the adoption of information technology.

The insignificant effect of social influence processes (subjective norm and image) is interesting as it relates to other studies of TAM2. Venkatesh and Davis [2] reported that subjective norm had a direct effect on intention to adopt that weakened over time. Our results suggest that, as a whole, pediatricians' decisions to adopt IHA are not influenced by peer pressures or how they will be perceived if they adopt the technology. Similar to the findings of Chau et al, the physicians in our study seemed to be rather independent in making technology adoption decisions, by not putting much weight on subjective norm or image, therefore not having concern about other's opinion on whether they should or should not adopt IHA. A recent study concluded that the insignificant effects of subjective norms on intention suggests that a physician, when making the technology acceptance decision, may value his or her own assessment more than that of others [8].

Our analysis reveals the importance of the perception usefulness and pragmatism by physicians for their adoption and use of information technologies in their clinical practices. This study has several limitations. First, our sample size was small because we targeted a particular subject group, pediatricians in Hawaii. Second, we emphasized Internet-based health applications in general as our targeted technology. Thus, caution needs to be taken when generalizing the findings and discussion to other technologies and professional groups.

Despite the limitations, results from this study have interesting implications and recommendations for future research. First, TAM2 was able to explain over half of the behavioral intention variance ($R^2 = .59$), which previous studies involving physicians were not able to explain [6,8]. Second, the results showing an insignificant effect for perceived ease of use combined with similar findings from previous TAM studies imply that this construct within TAM2 is not applicable in the professional context, specifically, physicians. Third, our findings suggests that physicians operate as individuals rather than as a monolithic group when deciding to adopt IHA, based on the lack of significance placed on subjective norm and image in this study and prior research [6,8].

The study presents implications for health care information technology management. To encourage the individual physician to adopt and use of IHA, the organizational management needs to 1) emphasize the usefulness of the technology to the physician, and 2) de-emphasize the ease of use of the particular information technology, while focusing on the importance and utility of the technology in performing daily tasks.

Recommendations for future research for understanding and thus enhancing physicians' adoption and use of IHA are:

1. A modified version of TAM2 would be very useful in assessing physicians' attitudes toward acceptance of Internet-based health applications. In developing this model, new constructs should be tested for the abstract notion of easy to use or "without effort". Physician-

centered variables with regards to ease of use should be defined.

2. Additional research is needed to examine the effects of physicians' characteristics on information technology adoption, evaluation and comparison of physicians across specialties, disciplines, geographic boundaries, and cultures would be valuable.

3. In addition, future studies should look at the effects of "hands-on" educational interventions on basic TAM2 relationships in a professional context. Perhaps the constructs "ease of use" and "subjective norm" would fair differently in a study if physicians had hands on experience with an actual technology and if a referent other as suggested by Rogers [16] introduced or encouraged use of a particular information technology.

APPENDIX: Survey Questions

Intention to Use
- Assuming that significant barriers to the use of IHA are overcome, I intend to use IHA.
- If significant barriers did not exist, I predict I would use IHA.

Perceived Usefulness
- IHA could increase my productivity.
- IHA could improve the quality of care that I deliver.
- IHA could enhance my effectiveness.
- IHA could be useful in my job.

Perceived Ease of Use
- My interaction with IHA will be clear and understandable.
- IHA will be easy to use.
- Interacting with IHA will not require a lot of mental effort.
- It will be easy to get IHA to do what I want them to do.

Subjective Norm
- Pediatricians who influence my behavior think I should use IHA
- Pediatricians who are important to me think I should use IHA

Image
- Having IHA will be a status symbol.
- Pediatricians who use IHA have more prestige than those who do not.
- Pediatricians who use IHA have a high profile.

Job Relevance
- Usage of IHA is relevant to the delivery of pediatric care.
- Usage of IHA is important to the delivery of pediatric care.

Output Quality
- The quality of consumer health information on the Internet is high.
- The quality of pediatric information currently on the Internet is high.
- The quality of professional information on the Internet is high.
- I expect the quality of future IHA to be high.

Result Demonstrability
- IHA could reduce the cost of my care delivery.
- I believe I could communicate to others the consequences of using IHA.
- The results of using IHA will be apparent to me.
- I would have difficulty explaining why using IHA may or may not be beneficial.

REFERENCES

[1] Davis, FD. Perceived usefulness, perceived ease of use and user acceptance of information technology. MIS Quarterly, 1989, 13;3;319-340.
[2] Venkatesh, V, Davis FD. A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management Science*. 2000; 46:2, 186-204.
[3] Medical Records Institute. Available Online at : http://www.medrecinst.com/ (Accessed on May 6, 2002).
[4] HIMSS/IBM Leadership Survey (2000). Healthcare Information and Management Systems Society (HIMSS). The 11th Annual HIMSS Leadership Survey Sponsored by IBM: Trends in Healthcare Information and Technology. Available online at http://www2.himss.org/survey/2000/survey2000.html. Accessed on May 6, 2002.
[5] Wang, K. and Song, K. (1997). The Physician and the Internet, *Mayo Clinic Procedures*, 72 (1), pp. 66-71.
[6] Hu, P, Chau, P, Tam, K. Examining the technology acceptance model using physician acceptance of telemedicine technology, *Journal of Management Information Systems,* 1999; 16;2, 91-112.
[7] Dixon, DR, Stewart, M. Exploring information technology adoption by family physicians: survey instrument valuation. *Proc. AMIA Symp* 2000.
[8] Chau, P.Y.K. and Hu, P.J-H. Investigating healthcare professionals' decision to accept telemedicine technology: an empirical test of competing theories. *Information and Management,* 2002, 39; 297-311.
[9] Shiffman, RN, Spooner, SA, Kwiatkowski, K, Brennan, PF. Information technology for children's health and health care: report on the information technology in children's health care expert meeting, September 21–22, 2000. J *Am*

Med Inform Assoc. 2001;8:546-551.

[10] Davis, F.D. (email communication, January 25, 2001).

[11] Nunnally, JC *Psychometric Theory,* 2d ed. New York: McGraw-Hill, 1978.

[12] American Academy of Pediatrics. Characteristics of pediatricians and their practices: the socioeconomic survey. Periodic Survey #43- Part 1. http://www.aap.org/research/ps43aexs.htm. Accessed February 15,2002.

[13] Jayasuriya, R. Determinants of microcomputer technology use: implications for education and training of health staff (1998). International Journal of Medical Informatics 50: 187-194.

[14] Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. User Acceptance of Computer Technology: A Comparison of Two Theoretical Models, *Management Science.* August 1989, 35:8, 982-1003.

[15] Keil, M., Beranek, P.M., and Konsynski, B.R. Usefulness and ease of use: filed study evidence regarding task considerations, *Decision Support Systems* 1995, 13:1, 75-91.

[16] Rogers, E.M. (1983). Diffusion of Innovations. (3rd ed.) New York: Free Press.