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Household Technology Use: Integrating Household Life Cycle and the Model of Adoption of Technology in Households

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Recently, the model of adoption of technology in households (MATH) was developed and tested in the context of household personal computer (PC) adoption. In this study, we apply MATH to predict personal computer (PC) use. We conducted a nationwide survey including 370 households that owned at least one PC. Results indicate that attitudinal beliefs are extremely important in determining use of a PC in the household. In contrast to previous work examining adopters, normative and control beliefs were not significant in predicting use. Furthermore, several determinants of adoption that were important at different stages of the household life cycle were found nonsignificant in predicting use for the same stages of the household life cycle. Overall, the results demonstrate that the belief structure for household PC use is different from that of household PC adoption. Further, the results provide additional evidence regarding the importance of including household life cycle in studies of household technology adoption and use.

Keywords attitudes, behavior, beliefs, household, household life cycle, model of adoption of technology in households (MATH), personal computer, technology adoption, use

The majority of research in information technology (IT) adoption has been focused on workplace settings, using knowledge workers and students as subjects (e.g., Davis et al., 1989; Venkatesh et al., 2003). However, as noted by Brown and Venkatesh (2005), households have become an important venue for IT use over the years. Limited research has been conducted to understand technology adoption and use in households (e.g., Brown & Venkatesh, 2005; Shih & Venkatesh, 2004; Venkatesh, 1996; Venkatesh & Brown, 2001). In general, this research has identified a number of factors that differentiate the household environment from the workplace, such as the variety of people involved in decision making, income factors, and the purpose for acquiring technology. Further, the nature of technology use in the household is different from that in the workplace (Venkatesh, 1996). Thus, it is reasonable to expect that workplace models of adoption would not neatly transfer to the household environment. Preliminary evidence that the household is a boundary condition of traditional technology adoption models was found in the development of a model for the adoption of technology in households, MATH (Venkatesh & Brown, 2001).

Recently, MATH was tested via a longitudinal survey of United States households (Brown & Venkatesh, 2005). The model was also extended to incorporate characteristics of household life cycles (Gilly & Enis, 1982; Schaninger & Danko, 1993). The results demonstrate that adoption of PCs in households is associated with key life-cycle characteristics, namely, age, income, presence/age of children in the household, and marital status. The results provide additional evidence of the differences in household versus workplace adoption. Other differences in adoption patterns have been found in

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research comparing adopters and users in workplace settings. Karahanna et al. (1999) found that different innovation characteristics were attended to by those who were already using an innovation as compared to those who were considering using it (i.e., potential adopters). These results have been supported in research examining continuance intention, or the intention of an individual to continue using a system he or she has already adopted (Bhattacherjee, 2001; Bhattacherjee & Premkumar, 2004). Given these differences in workplace adoption and use findings, combined with the differences across households and the workplace, we propose that, just as the household represents a boundary condition for traditional technology adoption models, *use* represents another important boundary condition. Specifically, we expect that the factors that influence continuing use of technology in households will be different from those that influence adoption in the household, as well as those that influence continuing use in the workplace.

In order to understand technology use in household contexts, we conducted a study on how the factors identified in MATH as predictors of technology adoption can predict technology use at households. Moreover, we examined these factors in the context of a household life cycle model to understand and isolate the factors that are important at different stages of household life cycle (e.g., bachelor, newlywed, single parent). Our research extends the current body of research on household technology adoption (e.g., Brown & Venkatesh, 2005; Hoffman et al., 2004; Shih & Venkatesh, 2004; Venkatesh & Brown, 2001; Venkatesh, 2005) in several important ways. First, as noted earlier, much prior research has focused on technology adoption (the factors leading to technology purchase) in household contexts (see, e.g., Brown & Venkatesh, 2005; Venkatesh & Brown, 2001). While the adoption of technology has been widely studied, there is limited research on technology *use* in household contexts (Shih & Venkatesh, 2004). The current study extends prior household technology adoption research by emphasizing postadoptive use of technology, a topic that has recently been identified as an important area of research (see, e.g., Jasperson et al., 2005; Shih & Venkatesh, 2004). Understanding what drives technology use in households can help both researchers and practitioners to develop various interventions to maximize the use of technology. Second, our research complements the recent work of Shih and Venkatesh (2004) by including additional key factors (e.g., attitudinal beliefs) that influence technology use in the household. Finally, this study makes an important contribution to research in technology adoption, technology use, and consumer behavior by incorporating household life-cycle models to understand the antecedents of technology use that are important at different stages of household life cycle.

THEORY

In this section we discuss MATH and household life-cycle models. We also discuss the gap in the extant research on MATH and how the current work addresses the gap.

Model of Adoption of Technology in Households (MATH)

Venkatesh and Brown (2001) developed MATH by drawing from relevant research in information systems (IS), marketing, and social psychology. Even though the technology of interest in MATH is the personal computer, the model is expected to generalize to other IT products and systems in the household context. The theory of planned behavior (TPB; Ajzen, 1991) was used as a guiding framework in the development of MATH. While TPB requires a belief elicitation procedure to determine the salient belief structure for a given behavior, Venkatesh and Brown (2001) proposed a decomposed belief structure for home personal computer (PC) adoption by drawing from prior technology adoption, consumer behavior, and psychology research. Consistent with TPB (Ajzen, 1991) and decomposed TPB (Taylor & Todd, 1995), MATH posits that a set of beliefs (i.e., attitudinal, normative, and control) will influence household PC adoption. Figure 1 presents MATH, and Table 1 provides the definition of MATH constructs.

The attitudinal belief structure in MATH is comprised of three outcome expectancies: *utilitarian outcomes*, *hedonic outcomes*, and *social outcomes*. Utilitarian outcomes is "defined as the degree to which using a PC enhances the effectiveness of household activities" (Venkatesh &

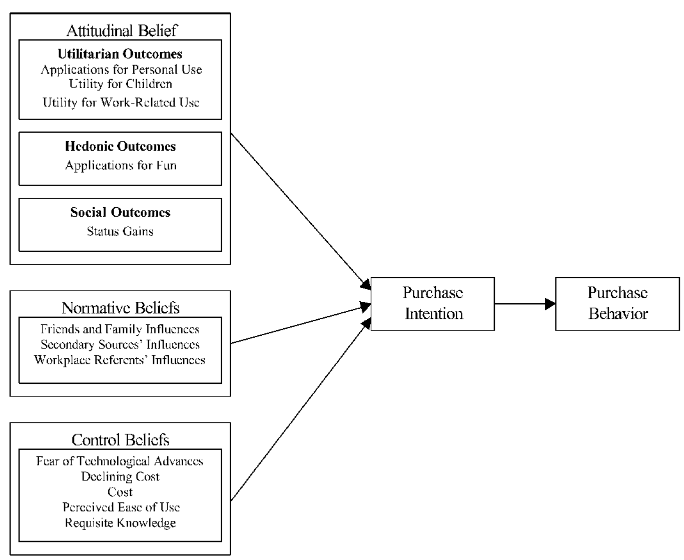

FIG. 1. Model of adoption of technology in households (MATH).

TABLE 1
MATH constructs

Belief structure	Core constructs	Definitions
Attitudinal beliefs	Applications for personal use	"The extent to which using a PC enhances the effectiveness of household activities" (Venkatesh & Brown, 2001, p. 82).
	Utility for children	The extent to which using a PC enhances the children's effectiveness in completing homework and other activities (Venkatesh & Brown, 2001).
	Utility for work-related use	The extent to which using a PC enhances the effectiveness of performing work-related activities (Venkatesh & Brown, 2001).
	Applications for fun	"The pleasure derived from PC use" (Venkatesh & Brown, 2001, p. 82). These are specific to PC use, rather than general traits (see Webster & Martocchio, 1992).
	Status gains	The increase in prestige that coincides with a purchase of the PC for home use (Venkatesh & Brown, 2001).
Normative beliefs	Friends and family influences	"The extent to which members of a social network influence one another's behavior" (Venkatesh & Brown, 2001, p. 82). In this case, the members are friends and family.
	Secondary sources' influences	The extent to which information from TV, newspaper, and other secondary sources influences behavior (Venkatesh & Brown, 2001).
	Workplace referents' influences	The extent to which coworkers influence behavior (see Taylor & Todd, 1995)
Control beliefs	Fear of technological advances	The extent to which rapidly changing technology is associated with fear of obsolescence or apprehension regarding a PC purchase (Venkatesh & Brown, 2001).
	Declining cost	The extent to which cost of a PC is decreasing in such a way that it inhibits adoption (Venkatesh & Brown, 2001).
	Cost	The extent to which the current cost of a PC is too high (Venkatesh & Brown, 2001).
	Perceived ease of use	The degree to which using the PC is free from effort (Davis, 1989; see also Venkatesh & Brown, 2001).
	Requisite knowledge	The individual's belief that he/she has the knowledge necessary to use a PC. This is very closely tied to the concept of computer self-efficacy (Compeau & Higgins, 1995; see also Venkatesh & Brown, 2001).

Brown, 2001, p. 74). Much prior research on technology adoption has suggested that individuals' perceptions about the productivity enhancement capability of technology are the strongest drivers of technology adoption. Utilitarian outcomes represent such instrumental aspects of technology adoption determinants. In the case of the household, utility with respect to personal applications, children, and work-related use was identified by the study participants. In addition, reduction in utility due to obsolescence was also mentioned. Hedonic outcomes represent the pleasure derived from the use of PC in households. MATH posits that in a household setting, the entertainment potential of a PC will have a strong influence on the adoption decision. Finally, social outcomes refer to the public recognition due to the adoption and use of an innovation—that is, a PC. MATH suggests that early adopters of PCs would gain substantial social status and referent power as they become the role models for the subsequent adopters. On the other hand, the use of obsolete technology should be associated with status losses. In sum, MATH posits that early adopters would place greater importance on the attitudinal belief structure than would the later adopters and nonadopters.

MATH incorporates *social influence* and various *secondary sources* as the basis for the normative belief structure. Social influence refers to "the extent to which members of a social network influence one another's behavior" (Venkatesh & Brown, 2001, p. 75). MATH posits that household adoption of PCs will be influenced by the views of relevant others, such as friends and family members, workplace colleagues, and other referents. MATH suggests that various secondary sources (i.e., mass media, such as TV and newspapers) will influence early adopters of PCs, whereas the later adopters will be influenced by direct social influence (e.g., word of mouth from friends, family, and other adopters).

The control belief structure represents the knowledge and resource barriers that can potentially obstruct the adoption of new technology (Mathieson, 1991; Taylor & Todd, 1995; Venkatesh & Brown, 2001). Three sources of control beliefs were suggested in the literature: *lack of knowledge*, *difficulty of use*, and *high cost*. Drawing on prior technology adoption research (Compeau & Higgins, 1995; Venkatesh & Davis, 1996), MATH posits that lack of knowledge regarding how to use a computer will significantly inhibit adoption of PCs in the household context, as individuals will be less likely to buy a technology that they cannot use. Similarly, if individuals believe that a PC will be difficult to use, they will be reluctant to adopt it. This is consistent with prior technology adoption research that suggests that perceived ease of use can be a significant barrier to technology adoption (Venkatesh, 1999; Venkatesh & Davis, 1996). MATH also suggests that the cost of a PC will be a key barrier of household PC adoption, as price is typically an important factor in consumers' buying decisions (e.g., Engel et al., 1990). Finally, MATH posits two additional control beliefs: *rapid change in technology and/or fear of obsolescence*, and *declining cost*. These beliefs were elicited from the study subjects and represent the impact that the rapidly changing PC market had on perceptions of control (Webster & Martocchio, 1992).

Using qualitative data collected in a two-wave longitudinal phone survey of households regarding their current and future ownership of a PC, Venkatesh and Brown (2001) empirically developed MATH. Recently, Brown and Venkatesh (2005) proposed several important extensions to MATH: (1) They renamed two constructs—that is, changing *high cost* to *cost* and *fear of obsolescence* to *fear of technological advances*, to make them consistent with prior research; (2) they changed the underlying structure of the model by suggesting a direct link between the beliefs and behavioral intention, thus making it more consistent with other technology adoption models; (3) they added a new source of normative beliefs—that is, *workplace referents' influences*; and (4) they integrated MATH with household life cycle stages to provide a richer understanding of household PC adoption. Brown and Venkatesh provided the first quantitative validation of MATH to predict the behavioral intention to adopt PC by those who had not yet purchased a PC for home use, that is, nonadopters. However, they did not examine the predictive capability of MATH regarding use of PCs in households. As prior research in the workplace has pointed out, nonadopters and users can be influenced by different factors (e.g., Karahanna et al., 1999). Thus, an important next step in further development of MATH is to examine its predictive ability in the context of household technology *use*.

Household Life Cycle

As noted earlier, Brown and Venkatesh (2005) incorporated household life cycle stages in MATH to better understand household adoption of PCs. Household life cycle stages have been used in the consumer behavior literature to understand how households at different stages of the household life cycle differentially make purchase decisions. The main thesis of household life cycle models is that households (i.e., families) progress through a systematic set of stages over the course of time and these varying stages have a significant impact on purchase and consumption behavior (Gilly & Enis, 1982; Schaninger & Danko, 1993; Wells & Gubar, 1966; Wilkes, 1995). Brown and Venkatesh employed the household life cycle model proposed by Gilly and Enis (1982). They selected this model because it is appropriate for newer forms of families (e.g., single parents, same-sex couples) and has received much attention in prior research (Schaninger & Danko, 1993). Table 2 presents the stages of the household life cycle proposed by Gilly and Enis (1982).

As shown in Table 2, there are 11 distinct stages of household life cycle. These stages differ on the basis of three key characteristics: *marital status*, *age*, and *children*. For example, in Bachelor 1 stage, the marital status is single, the age is under 35 years, and there are no children living in the home. Brown and Venkatesh (2005) noted that some researchers (e.g., Wagner & Hanna, 1983) proposed *income*, rather than household life cycle stages, as a key determinant of household purchasing behavior. Yet even the results of Wagner and Hanna's (1983) study indicated that income could not directly substitute for household life cycle. Thus, Brown and Venkatesh (2005) suggested that household PC purchase behavior is a function of a household's life cycle stages and income. Particularly, they theorized that there will be an interaction among MATH constructs, household life cycle stages, and income such that in the context of household PC adoption, MATH constructs will play different roles at different stages in the household life cycle and for different income levels.

Brown and Venkatesh (2005) found that the integrated model explained about 74% of the variance in intention to adopt PC. Specifically, they found that attitudinal beliefs (see Figure 1) varied by life cycle stages such that (1) applications for personal use was more important for households with older and married individuals; (2) utility for children was significantly important for households with older children; (3) utility for work was significant for

TABLE 2
Stages in the Gilly–Enis (1982) family life cycle

		Characteristics		
Stage number	Stage	Marital status	Age	Children
1	Bachelor I	Single person living alone	Under 35	None
2	Bachelor II	Single person living alone	Age 35–64	None
3	Newlywed	Two adults living together	Female under age 35 (if both males, younger under age 35)	None
4	Single parent	One adult	Any age	Any number of children, any age
5	Full nest I	Two adults living together	Female adult under age 35 (if no female, younger male)	Youngest child under age 6
6	Delayed full nest	Two adults living together	Female adult 35 or older (if no female, younger male)	Youngest child under age 6
7	Full nest II	Two adults living together	Female adult under age 35 (if no female, younger male)	Youngest child age 6 or above
8	Full nest III	Two adults living together	Female adult 35 or older (if no female, younger male)	Youngest child age 6 or above
9	Childless couple	Two adults living together	Female under age 65 (if no female, younger male)	None
10	Older couple	Two adults living together	Female 65 or older (if no female, younger male)	None
11	Bachelor III	Single person living alone	Age 65 or older	None

bachelors and childless couples; (4) applications for fun was significant for bachelors and full nest families; and (5) status gains were significant for full nesters. Where normative influences were significant, they interacted with income, with workplace referents playing a significant role only for single parents. The control beliefs of fear of technological advances, declining cost, and cost also had a significant interaction with income, not surprisingly. Finally, perceived ease of use was significant for bachelors, older full nest families, childless couples, and older couples/bachelors, while requisite knowledge was significant only for the childless couples and older couples/bachelors.

MATH was developed to explain adoption in the household. Yet some recent research has called for more attention to paid to use (e.g., Jasperson et al., 2005; Shih & Venkatesh, 2004). Jasperson et al. (2005) call for research on postadoptive use of technology to understand use behavior (i.e., feature adoption, use, extension) after a technology is installed and made accessible to individuals. Shih and Venkatesh (2004) provide the results of an empirical study employing a use-diffusion model. Their results support a four-dimensional view of use based on rate and variety of technology use.

While Brown and Venkatesh (2005) provided the first quantitative validation of MATH, their analysis was limited to potential adopters of PCs. Some recent research has called for more attention to be paid to use behavior (e.g., Jasperson et al., 2005). Shih and Venkatesh (2004) employed a use-diffusion view to examine the variety and rate of use, resulting in a four-dimensional view of household technology use. Thus, recent research points toward the importance of understanding use, as well as the limited research on it. In the workplace, prior research (e.g., Bhattacherjee & Premkumar, 2004; Karahanna et al., 1999) indicates that users may place different levels of importance on the drivers of adoption when compared to potential adopters. Specifically, attitudinal beliefs that are formed based on direct experience with the behavior predict behavior better than attitudinal beliefs formed without direct experience (Fazio & Zanna, 1981). In the absence of direct experience with a household PC, household members would need to gather information in order to reduce their uncertainty regarding the PC (Burkhardt & Brass, 1990). However, direct experience serves to reduce uncertainty, and thus lessen the need to confer with those sources (Karahanna et al., 1999). We thus propose:

> Proposition 1: Attitudinal beliefs will contribute more to the explanation of usage behavior than will normative beliefs.

In addition, Venkatesh and Brown (2001) refer to the control beliefs as a sort of barrier to adoption. Since adoption has occurred, this barrier has been overcome. Thus, we anticipate that control beliefs will not have a significant impact on use. We thus propose:

> Proposition 2: Control beliefs will not be significant in predicting household PC use.

Given that Brown and Venkatesh (2005) found the pattern of factors significant in predicting household PC adoption differed across life-cycle stage, we anticipate the same will be true for use. We do, however, anticipate that the patterns predicting use will be different from those predicting adoption. From a theoretical perspective, we expect that due to unique characteristics—marital status, age, and children—of each household life cycle stage, the drivers of PC use will be different. For example, *utility for children* may not be a driver of PC use for families at certain stages of household life cycle, such as bachelor I, bachelor II, newlywed, and childless couples. However, utility for children is expected to be an important driver of PC use for households with children, such as single parent, full nest, and delayed full nest. Similarly, normative beliefs (e.g., friends and family influence) are expected to be important drivers for PC use for older couples who may not have enough prior experience with PCs, and who therefore may not be aware of the myriad ways a PC can be used to improve personal productivity and/or for entertainment. We thus propose:

> Proposition 3a: The pattern of factors significantly predicting usage behavior will differ based on household life cycle stage.

We expect that the factors influencing PC *adoption* at various stages of the household life cycle may not be the same for PC *use* for the same household stages. For example, utility for children was found to be an important driver of adoption for households that either already have children or are expecting to have children very soon (see Brown & Venkatesh, 2005). Due to the availability of various PC applications for children (e.g., games and game-based learning software), children have become one of the largest groups of PC users in households over the last few years (Subrahmanyam et al., 2004). Thus, in the case of PC use, we expect that utility for children will be a significant predictor of technology use only for those stages of household life cycle that actually have one or more children (e.g., full nest or delayed full nest). In terms of control beliefs, Brown and Venkatesh (2005) found that perceived ease of use was a significant predictor of PC adoption for bachelor I and II and for childless couples, while requisite knowledge was a significant predictor of adoption for childless couples and older couples. Through use, household members are able to develop clearer assessments of ease of use and their knowledge levels. Thus, we expect that control beliefs are more like to be significant predictors of PC use for households with relatively older family members—such as full nest II, full nest III, and older couples—as use is likely to highlight the lack of computer aptitude and/or experience with computers for these households (see, e.g., Morris & Venkatesh, 2000). Therefore, factors that are important for PC adoption at a certain life cycle stage may not be important for PC use at the same life cycle stage. Thus, we expect:

> Proposition 3b: The pattern of factors predicting usage behavior within a life cycle stage will be different from the pattern predicting adoption.

Finally, given that these households have already purchased a PC, and have thus attended to the issues associated with cost, we anticipate that income will not be a significant moderator for users. We thus propose:

> Proposition 4: Within household life cycle stages, income will not be a significant moderator in predicting household PC use.

METHOD

This study was conducted as part of a larger research project about household technology adoption and use supported by a major electronic retail store. Data were collected through a nationwide longitudinal survey of U.S. households regarding adoption and use of PCs. A marketing research firm and the sponsoring electronics retailer provided assistance with identifying the households and offering incentives for participation.

Participants and Procedures

While there are different approaches to collecting household data (e.g., interviewing the head of household, surveying all members of the household, etc.), we collected data from the primary decision maker of each household. Even though there are other key roles in a household purchase decision scenario (e.g., gatekeepers, influencers, buyers, and consumers), it is the decision maker who makes the final decision regarding product purchase. While the decision maker makes the final decision, the decision is typically influenced by the opinions expressed by the other members in the household (Lackman & Lanasa, 1993). Therefore, we expect that the opinions of the decision makers regarding household PC use represent the collective opinions of all the household members.

In total, 5400 households were randomly selected by the marketing research firm from their database of residential addresses. In addition to a lottery grand prize of a \$500 gift certificate, the sponsoring electronic retailer offered \$5 gift certificates to all respondents completing the survey as an incentive to increase response rate. In total, 1247 usable responses were received in an 8-week period. The response rate was just over 24%. The responses represented 501 households that owned at least one PC during the time of the survey (i.e., current owners). The remaining 746 households did not possess a PC at the time of the initial survey (i.e., potential adopters). Six months after the initial survey, a follow-up survey was conducted to gather the information regarding the behavior—that is, use for the current owners and purchase behavior for the potential adopters. In total, 370 current owners responded to the follow-up survey, thus constituting the sample for this study. Additional details regarding the method are available in Brown and Venkatesh (2005). It should be noted that Brown and Venkatesh (2005) reported the data related to the potential adopters and examined drivers of adoption, whereas the current study reports data related to the current owners of PCs and examines drivers of use.

Instrument Development and Pilot Testing

Validated instruments were used to operationalize the constructs where applicable. A detailed discussion on instrument development and validation for MATH constructs is provided by Brown and Venkatesh (2005). Household life-cycle-data, including age of household members, income, marital status, and the presence of children, were also collected. Use was measured 6 months after the initial survey, using a 3-item self-report of average use over the past 6 months that focused on frequency, duration, and intensity of use (Davis et al., 1989). The survey instruments were validated using a pilot study. At first, the instruments were assessed by a group of peers, a panel of managers at the market research firm, and a panel at the sponsoring retail store in order to ensure content and face validity (Straub et al., 2004). Modifications were made based on the feedback received from these individuals. Next, four focus groups were formed with eight heads of household in each group to evaluate the instrument. Minor changes were made based on their feedback. Finally, a pilot study was conducted with 36 heads of households. The respondents were able to finish the survey in about 15 minutes. Despite the small sample size, we found that the scales had adequate reliability and validity.

RESULTS

PLS-Graph (version 2.91.03.04) was used to analyze the data. Table 3 presents the descriptive statistics for the measures, the internal consistency reliability (ICR), the average variance extracted (AVE), and the correlation matrix for all the constructs in the study. All ICRs were .75 or above, indicating strong reliability of the instrument. The factor loadings in all cases were greater than .65 and cross-loadings were .35 or lower. Furthermore, the AVEs for each construct were greater than the interconstruct correlations. Therefore, the constructs had adequate convergent and discriminant validity.

Baseline Model Testing

Table 4 presents the results for the baseline model for the current users. Results for the potential adopters from Brown and Venkatesh (2005) are also included for a direct comparison. As shown in Table 4; only the constructs representing attitudinal beliefs are significant predictors of household PC use behavior. This overall pattern of results is consistent with Propositions 1, 2, 3a, and 3b. *Applications for personal use* is the strongest predictor of household PC use ($\beta = .33$, $p < .001$). This is consistent with Brown and Venkatesh (2005), who found that applications for personal use was the strongest predictor of PC purchase intention. This is one of three attitudinal beliefs that predict both adoption and use. This result is consistent with much prior technology adoption research that has found that *performance expectancy*—the degree to which technology enhances an individual's performance—is the strongest predictor of behavioral intention to use a technology (see Venkatesh et al., 2003).

Utility for children is also a significant predictor of PC use ($\beta = .17$, $p < .05$). However, Brown and Venkatesh (2005) found that utility for children was not a significant predictor of purchase intention. Potential adopters may not be aware of various ways a PC can be useful for their children because of their possible lack of experience with a PC. However, with direct experience, current owners have a better understanding of how a PC can be useful for their children. Therefore, utility for children can increase PC use, as individuals may help their children to use a PC or may use a PC to find different interesting things for their children.

TABLE 3
Correlation matrix

	Constructs	M	SD	ICR	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Applns. for personal use	4.66	1.03	.92	.77													
2	Utility for children	4.58	1.07	.90	.28***	.80												
3	Utility for work-rel. use	4.90	1.10	.88	.39***	.19*	.83											
4	Applns. for fun	4.33	0.99	.87	.20**	.29***	.21**	.82										
5	Status gains	4.22	0.78	.85	.07	.08	.06	.10	.81									
6	Friends and family infl.	4.08	0.82	.90	.16*	.28***	.18*	.20*	.13	.76								
7	Secondary sources' infl.	4.01	0.71	.88	.19**	.26***	.19**	.08	.10	.25**	.77							
8	Workplace referents' infl.	3.13	0.56	.92	.08	.16*	.18*	.19*	.26***	.69***	.36***	.80						
9	Fear of tech. change	2.86	0.58	.90	.08	.08	.13	−.09	−.22**	−.13	.08	.08	.81					
10	Declining cost	4.09	0.87	.89	.13	.09	.08	−.03	.08	.09	.10	.09	.37***	.84				
11	Cost	2.95	0.62	.80	.02	.10	.16*	−.12	.03	−.02	.05	.16*	.20*	.34***	.80			
12	Percd. ease of use	4.75	0.76	.92	.19**	.02	.16*	.19*	.10	.02	.09	.08	−.19	.07	.14	.79		
13	Requisite knowledge	4.93	0.78	.80	.18*	.06	.10	.12	.07	.16*	.07	.16*	−.20*	.08	.12	.29***	.80	
14	Usage	N/A	N/A	N/A	.26***	.28***	.19**	.19*	.18*	.16*	.19*	.17*	.13	.11	0.18**	.23**	.19*	N/A

Note. Applns., applications; ed., related; infl., influence; tech., technological; percd., perceived. Significance: * $p < .05$; ** $p < .01$; *** $p < .001$.
Diagonal elements are square root of AVEs (average variance extracted). In order to have discriminant validity, the diagonal elements should be higher than the off-diagonal elements. NA, not applicable.

TABLE 4
MATH results

	Current study: Dependent variable, use		Brown and Venkatesh (2005): Dependent variable: Purchase intention	
	R^2	Beta	R^2	Beta
A1: Applications for personal use	.57	.33***	.50	.28***
A2: Utility for children		.17*		ns
A3: Utility for work-related use		.15*		.21**
A4: Applications for fun		.28***		.17*
A5: Status gains		ns		ns
SN1: Friends and family		ns		.17*
SN2: Secondary sources		ns		.17*
SN3: Workplace referents		ns		ns
PBC1: Fear of technological change		ns		−.22***
PBC2: Declining cost		ns		.15*
PBC3: Cost		ns		−.16*
PBC4: Perceived ease of use		ns		.16*
PBC5: Requisite knowledge for PC use		ns		ns

Note. Significance: * $p < .05$; ** $p < .01$; *** $p < .001$.

Utility for work-related use is also a significant predictor of PC use ($\beta = .15$, $p < .05$). This is another attitudinal belief that predicts both adoption and use (see Brown & Venkatesh, 2005). Thus, it seems that work-related use is not used simply to justify that the purchase of a PC for home use would be a good idea; it is in fact an important component of usage behavior.

Applications for fun is another strong predictor of PC use ($\beta = .28$, $p < .001$). While Brown and Venkatesh (2005) found applications for fun to be a significant predictor of adoption, its relative impact was much smaller. It is likely that when individuals develop their intention to purchase a PC, they may not be aware of various ways a PC can be used for entertainment. However, once they purchase a PC, they discover different ways to use the PC for entertainment purposes. Moreover, with the availability of high-speed Internet and advanced media streamlining technologies, it is now possible to use a PC for various entertainment purposes (e.g., watching movies, listening music). Individuals can also use a PC for personal communication purposes (e.g., e-mail, instant messaging), which can be a source of enjoyment (Venkatesh et al., 2000). These various ways of using a PC as a source of entertainment may not be known to individuals who do not own a computer. Thus, it makes sense that applications for fun is not as important to the potential adopters as it is for the current owners.

One of the attitudinal constructs, *status gains*, is not a significant predictor of PC use. Brown and Venkatesh (2005) also did not find it to be a significant predictor of purchase intention. These results are quite likely due to the private nature of PC consumption. When products are consumed in private, the impact of status effects is significantly diminished (Bearden & Etzel, 1982). Venkatesh and Brown (2001) raise this notion of private versus public consumption as a potential factor in household PC adoption. We revisit this in the discussion.

We found that none of the normative and control belief constructs was significant predicting PC use. However, Brown and Venkatesh (2005) found that two normative belief constructs—*friends and family influence* and *secondary sources' influences*—were significant predictors of purchase intention, but *workplace referents' influences* was not a significant predictor. These results indicate that once the PC purchase is made and the household members have had direct experience with it, they no longer rely on the influence of others. This provides evidence to support Proposition 1.

Brown and Venkatesh (2005) found that, except for *requisite knowledge*, all other control belief constructs—*fear of technological advances*, *declining cost*, *cost*, and *perceived ease of use*—are significant predictors of purchase intention. However, we found none of these to be significant in predicting PC use. These results indicate that individuals no longer worry about the rapid changes in technology and cost of technology once the adoption decision is made. Moreover, the fear associated with the complexity of the technology diminishes once the technology is purchased and there is direct experience using it. These results provide evidence in support of Proposition 2.

TABLE 5
MATH in household life cycle stages (dependent variable: use)

	S1: Bachelor I and bachelor II	S2: Newlywed	S3: Single parent	S4: Full nest I and delayed full nest	S5: Full nest II and full nest III	S6: Childless couple	S7: Older couple and bachelor III
A1	√	√	—	√	√	√	—
A2	—	—	√	√	√	—	—
A3	√	√	√	√	√	√	—
A4	√	√	√	—	—	√	√
A5	—	—	—	—	—	—	—
SN1	—	—	—	—	—	—	√
SN1 × Inc	—	√	√	—	—	—	—
SN2	—	—	—	—	—	—	√
SN2 × Inc	—	—	√	—	—	—	—
SN3	—	—	—	—	—	—	—
SN3 × Inc	—	—	√	—	—	—	—
PBC1	—	—	—	—	—	—	—
PBC1 × Inc	—	—	—	—	—	—	—
PBC2	—	—	—	—	—	—	—
PBC2 × Inc	—	—	—	—	—	—	—
PBC3	—	—	—	—	—	—	—
PBC3 × Inc	—	—	—	—	—	—	—
PBC4	—	—	—	—	√	—	√
PBC5	—	—	√	—	√	—	√

Note. The check marks indicate that a construct is significant at a particular household life cycle stage.

Model Testing by Life Cycle Stages

Table 5 presents the MATH results by life cycle stage for current owners. Table 5 shows whether or not a particular coefficient is significant for a given household lifecycle stage. As shown in Table 5, some stages were collapsed in order to accommodate for small sample sizes within stage. Brown and Venkatesh (2005) discussed the theoretical justification for such collapsing of stages. Consistent with their results, *applications for personal use* was significant for almost all life cycle stages, as households use PCs for productivity enhancement (e.g., online shopping, searching information for home improvement artifacts, appliances, and tools). *Utility for children* was a significant predictor of use for families that have children. *Utility for workrelated use* was significant for all stages except the older individuals, who are more likely to be retired and thus would not use a PC for work-related purposes. *Applications for fun* was more important for bachelors, newlyweds, single parents, childless couples, and older couples, as these individuals are more likely to use PCs for entertainment purposes such as listening to music, online games, watching movies, or even online gambling. However, this construct is not significant for various levels of full nest households, as individuals in these households may not have the time or opportunity to use computers for entertainment purposes because they are likely to be more occupied with their children. Status gains was not significant for any stage of households PC use, likely for the reasons mentioned previously.

In terms of normative beliefs, *friends and family influence* was important for older couples. Further, friends and family influences were significant for newlyweds and single parents with lower income. Interestingly, Brown and Venkatesh (2005) found that friends and family influences were only significant in predicting purchase intention for lower income households in the newlywed, full nest, childless couple, and older couple stages. In the absence of income as a moderator, friends and family influences were nonsignificant. Contrary to our expectations that the nature of household PC consumption as "private" direct experience would reduce the influence of others, it seems that once a PC is purchased, households in certain stages of the life cycle continue to be influenced by their friends and family members. Secondary sources were found to be significant for lower income single parents and older couples. Finally, workplace referents' influence was significant only for lower income single parents, indicating that even after purchase, single parents place importance on the information received from their colleagues in making their usage decisions.

Consistent with Brown and Venkatesh (2005), three normative beliefs—*fear of technological advances*, *declining cost*, and *cost*—were not significant predictors of use for any stages of household life cycle. As we noted earlier, there is no theoretical rationale for these constructs to predict use for the current owners of PC, since they have already made the purchase decision, and thus overcome the barriers to adoption (Venkatesh & Brown, 2001). In contrast to Brown and Venkatesh (2005), these factors are nonsignificant, even for low-income households. Perceived ease of use was a significant predictor of use for families with children and older individuals. There are likely two explanations for this. First, for single parents and the full nests with older children, the decision makers—the parents—potentially know less about the computer than their children (Kiesler et al., 2000). Thus, they may see perceived ease of use as an inhibitor to their use. For older couples and older bachelors, there are no children around who know how to use a computer, and thus ease of use is quite likely to influence their ability to use the PC. Finally, requisite knowledge was important for single parents and older families. For older individuals (e.g., full nest II and III and other older couples), requisite knowledge is important to use a PC as they may not have a general computer aptitude due to their lack of experience with computers. Single parents, for whom time is an extremely precious commodity (Hale, 2005), may simply be unable to devote the time necessary to learn how to use the PC. Overall, this pattern of results supports Propositions 3a and 3b, and provides partial support for Proposition 4.

DISCUSSION

This study represents the first empirical test of MATH with respect to *users* of household PCs. We build on the research of Venkatesh and Brown (2001) and Brown and Venkatesh (2005) in order to examine MATH's explanatory power for household PC use. We demonstrate that for users, attitudinal beliefs are the most significant influence on behavior. This is in contrast to the results found for adopter, which demonstrated that attitudinal, normative, and control beliefs were all significant (Brown & Venkatesh, 2005).

This research contributes to the technology adoption and use literature by offering key insights regarding the differences between adoption and use. We found that the drivers of PC use are significantly different from the drivers of PC adoption in household contexts. Prior research examining the differences between adopters and users in the workplace has found that direct experience alters the belief structure for users (Karahanna et al., 1999). Our study contributes to that research by providing additional evidence of the difference between users' and adopters' belief structures. Further, since this study was conducted in the household, it provides evidence that direct experience has a similar impact both in and out of the workplace.

Brown and Venkatesh (2005) recently demonstrated that a household life cycle view of adoption decisions improves our understanding of household PC adoption. Specifically, they demonstrated that while certain characteristics, such as utility for children, were not significant in a general model, when examined within the life cycle stages they became significant at certain stages. Our results further support this pattern. Importantly, when examined in aggregate, household PC use did not appear to be influenced by normative or control beliefs. Yet when examined in light of the household life cycle stages, they were found to be significant for certain stages. This provides additional evidence regarding the importance of incorporating household life cycle stage in research examining household technology adoption and use behavior.

Our research also contributes to the literature on habit as a predictor of technology use (see, e.g., Limayem & Hirt, 2003). Limayem and Hirt found that the key predictors of technology use are intentions (conscious factors) and habit (subconscious factor). The significant predictors of PC use in our research are primarily related to conscious factors; thus, our findings extend Limayem and Hirt's work by suggesting additional conscious factors that can predict technology intentions, and consequently, use. Furthermore, Limayem and Hirt found that *facilitating conditions*—a construct conceptually similar to perceived behavioral control of our model (see Venkatesh et al., 2003)—was not a significant predictor of technology use. Our findings are consistent with this, as none of our perceived behavioral control variables were significant predictors of PC use. We did not, however, assess the impact of habit in explaining household technology use. From a theoretical perspective, once technology use becomes habitual, it is more likely that individuals place less importance on the control beliefs as they become more familiar with the technology. Thus, habit may very well play a role in household technology use and should be incorporated in future research. We believe that this would enrich the nomological network of PC use in households.[1]

From a practical perspective, the use of the life-cycle approach provides important information for commercial and government interests wishing to maximize PC and technology use across U.S. households. For example, our results indicate that secondary sources (e.g., mass media) are important for influencing households with single parents and older couples to use their PC. Therefore, when considering eGovernment initiatives, mass media could be use to promote involvement specifically for these groups of individuals. With the advancement of high-speed telecommunication and Internet applications, it is now possible to perform various activities pertinent to the family and the household via the Internet using a PC (e.g., credit card bill payment, utility bills payment, bank balance checking, household items purchasing). Various secondary sources can be used to promote these services to older couples. Another example is that our results highlight the importance of ease of use and requisite knowledge, particularly for older adults. This suggests that programs aimed at encouraging PC, and potentially Internet, use among older adults should focus on helping them develop the knowledge necessary to use the PC.

This research also has implications for the IT industry and computer retailers. As per our findings, household members primarily use a PC for their personal productivity, children, and entertainment purposes. Vendors can develop PCs with necessary hardware and software components to support these applications. For example, households with one or more children are more likely to use a PC for games and other entertainment purposes (e.g., listening to music and watching videos). Therefore, vendors can package PCs with state-of-the-art hardware and software, such as for games and entertainment, targeting these types of households. Or, as in the case of the XBox360, games and entertainment can be packaged with state-of-the-art hardware to target these households. Similarly, consumer electronics retailers can promote specific products targeting specific types of households to maximize their sales and customer satisfaction.

This research offers some important directions for future studies. One important issue that remains unresolved is the private versus public nature of consumption regarding household PCs. Venkatesh and Brown (2001) raised this as a potential factor in understanding the influence of significant others. In terms of household PC adoption, however, it has yet to be examined. Our results suggest that PCs may fall in the private consumption category, as evidenced by the nonsignificance of normative influences. But as Venkatesh and Brown (2001) indicated, the connectivity associated with PCs can certainly be a factor influencing the private versus public nature of PC consumption. In addition, at the time this data was collected, PCs would be considered a luxury, as less than half of all households owned at least one. As this percentage increases, PCs will move from luxuries to necessities (Childers & Rao, 1992), which may alter the factors influencing both adoption and use.

Much prior cross-cultural research has suggested that the theories developed in Western settings may not be generalized in other contexts. With the declining cost of PCs and other peripheral devices, the rate of PC adoption in households is also increasing in many underdeveloped countries in the world (McCarthy, 2005; WITSA, 2004). Much of the research to date on home technology adoption and use has been conducted in Western contexts. Given the questionable generalizability of these results to other cultures, it is important to conduct studies on home PC adoption and use in non-Western cultural settings. Cross-cultural studies in homes will help us to understand the unique set of factors that drives household technology adoption and use in these contexts.

An important, yet underinvestigated, area related to our research is the nonproductive and/or negative use of technology—for example, Internet addiction behavior.[2] As PCs diffuse and assimilate in the household lifestyle at an exponential rate and access to Internet becomes easier and cheaper, it is more likely that household members will use the Internet for a variety of purposes (Hoffman et al., 2004; Venkatesh, 2005; Venkatesh et al., 2003). However, there is evidence that household members are becoming increasingly addicted to the Internet and spending long hours online for various purposes (see, e.g., Young, 1998). Future research should empirically investigate the factors leading to Internet addiction and possible interventions to minimize or control such addiction. This would likely require different conceptualizations of use. For example, the factors of rate and variety that Shih and Venkatesh (2004) employ could be further developed to account for negative use behaviors.

As more and more different types of technologies diffuse and are used in households, future research should explore MATH's predictive capability for these other household technologies (e.g., iPod, XBox). An important first step in that direction will be to develop a method of categorizing household (and other) technologies along dimensions that will be particularly important for households at various stages. Further, as technology enables even more connectivity and information sharing, issues associated with protection–such as security and privacy—may be important considerations for expanding MATH for both adopters and users.

Extending the work of Shih and Venkatesh (2004) by integrating their diffusion view of use with our view, based in the theory of planned behavior and household life cycles, would be an interesting avenue for future research. By employing their expanded conceptualization of use, research would paint an even more accurate picture of how and why technologies are used in the household. Results of this integrated view would likely provide additional insight for retailers as they design and market their technology-based products. Additionally, a greater understanding of use behavior across household stages would provide valuable information regarding the impact of eGovernment initiatives on various subsets of the population.

CONCLUSION

The objectives of this study were to examine MATH's predictive ability for household usage behavior, delineate the patterns of significant factors for use across household life cycles, and compare the results with those of Brown and Venkatesh (2005) to discern important differences. MATH appears to predict equally well for users as adopters. The results demonstrate that users and adopters differ, such that users focus on attitudinal beliefs to the exclusion of normative and control beliefs. Further, the results provide additional evidence of the importance of household life cycles in understanding both PC adoption and use.

NOTES

1. We thank an anonymous reviewer for this idea.
2. We thank an anonymous reviewer for this idea.

REFERENCES

Ajzen, I. 1991. The theory of planned behavior. *Organizational Behavior and Human Decision Processes* 50:179–211.

Bearden, W. O., and Etzel, M. J. 1982. Reference group influence on product and brand purchase decisions. *Journal of Consumer Research* 9(2):183–94.

Bhattacherjee, A. 2001. Understanding information systems continuance: An expectation-confirmation model. *MIS Quarterly* 25(3):351–370.

Bhattacherjee, A., and Premkumar G. 2004. Understanding changes in belief and attitude toward information technology usage: A theoretical model and longitudinal test. *MIS Quarterly* 28(2):229–254.

Brown S. A., and Venkatesh V., 2005. Model of adoption of technology in households: A baseline model test and extension incorporating household life cycle. *MIS Quarterly* 29(3):399–26.

Burkhardt, M., and Brass, D. 1990. Changing patterns or patterns of change: The effects of a change in technology on social network structure and power. *Administrative Science Quarterly* 35:104–127.

Childers, T. L., and Rao, A. R. 1992. The influence of familial and peer-based reference groups on consumer decisions. *Journal of Consumer Research* 19:198–211.

Compeau, D., and Higgins, C. A. 1995. Application of social cognitive theory to training for computer skills. *Information Systems Research* 6(2):118–143.

Davis, F. D., Bagozzi, R. P., and Warshaw, P. R. 1989. User acceptance of computer technology: A comparison of two theoretical models. *Management Science* 35:982–1002.

Engel, J. F., Blackwell, R. D., and Miniard, P. W. 1990. *Consumer behavior*. Chicago: Dryden Press.

Fazio, R. H., and M. P. Zanna. 1981. Direct experience and attitude-behavior consistency. In *Advances in experimental social psychology ed.* Leonard Berkowitz, vol. 14, pp. 161–202. New York: Academic Press.

Gilly, M. C., and Enis, B. M. 1982. Recycling the family life cycle: A proposal for redefinition. *Advances in Consumer Research* 9:271–276.

Hale, J. M. 2005. *Conscious prioritization* http://www.parentsworld.com, accessed 30 October 2005.

Hoffman, D. L., Novak, T. P., and Venkatesh, A. 2004. Has the Internet become indispensable? *Communications of the ACM* 47(7):37–42.

Jasperson, J., Carter, P. E., and Zmud, R. W. 2005. A Comprehensive conceptualization of post-adoptive behaviors associated with information technology enabled work systems. *MIS Quarterly* 29(3):525–557.

Karahanna, E., Straub, D. W., and Chervany, N. L. 1999. Information technology adoption across time: A cross-sectional comparison of pre-adoption and post-adoption beliefs. *MIS Quarterly* 23(2):183–213.

Kiesler, S., Zdaniuk, B., Lundmark, V., and Kraut, R. 2000. Troubles with the internet: The dynamics of help at home. *Human–Computer Interaction* 15:323–351.

Lackman, C., and Lanasa, J. M. 1993. Family decision-making theory: An overview and assessment. *Psychology & Marketing* 10(2):81–93.

Limayem, M., and Hirt, S. G. 2003. Force of habit and information systems usage: Theory and initial validation. *Journal of the Association for Information Systems* 4:65–97.

Mathieson, K. 1991. Predicting user intentions: Comparing the technology acceptance model with the theory of planned behavior. *Information Systems Research* 2(3):173–191.

McCarthy, J. C. 2005. *The state of Asia Pacific technology adoption and governance*. Springfield, MO: Forrester Group.

Morris, M.G., and Venkatesh, V. 2000. Age differences in technology adoption decisions: Implications for a changing workforce. *Personnel Psychology* 53:375–403.

Schaninger, C. M., and Danko, W. D. 1993. A Conceptual and empirical comparison of alternative household life cycle models. *Journal of Consumer Research* 19:580–594.

Shih, E. C., and Venkatesh, A. 2004. Beyond adoption: Development and application of a use-diffusion model. *Journal of Marketing* 68:1:59–72.

Straub, D., Boudreau, M. C., and Gefen, D. 2004. Validation guidelines for IS positivist research. *Communications of the Association for Information Systems* 13:380–427.

Subrahmanyam, K., Kraut, R., Greenfield, P., and Gross, E. 2000. The impact of home computer use on children's activities and development. *The Future of Children: Children Computer Technology* 10(2):123–144.

Taylor, S., and Todd, P. A. 1995. Understanding information technology usage: A test of competing models. *Information Systems Research* 6(2):144–176.

Venkatesh, A. 1996. Computers and other interactive technologies for the home. *Communications of the ACM* 39(12):47–54.

Venkatesh, A. 2005. The tech enabled networked home: An analysis of current trends and future promise. In *Transforming enterprise,* eds. W. H. Dutton, B. Kahin, R. O'Callaghan, and A. W. Wyckoff, Cambridge, MA: MIT Press.

Venkatesh, V., and Brown, S. A. 2001. A longitudinal investigation of personal computers in homes: Adoption determinants and emerging challenges. *MIS Quarterly* 25(1):71–102.

Venkatesh, V., and Davis, F. D. 1996. A model of the antecedents of perceived ease of use: Development and test. *Decision Sciences* 27:451–481.

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. 2003. User acceptance of information technology: Toward a unified view. *MIS Quarterly* 27(3):425–478.

Venkatesh, A., Shih, E. C., and Stolzoff, N. C. 2000. A longitudinal analysis of computing in the home based on census data 1984–1997. In *Home informatics: Information, technology, and society,* eds. A. Sloane and F. van Rijn, pp. 205–215. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Wagner, J., and Hanna, S. 1983. The effectiveness of family life cycle variables in consumer expenditure research. *Journal of Consumer Research* 10:281–291.

Webster, J., and Martocchio, J. J. 1992. Microcomputer playfulness: Development of a measure with work place implications. *MIS Quarterly* 16(2):201–226.

Wells, W. D., and Gubar, G. 1966. Life cycle concept in marketing research. *Journal of Marketing Research* 3:355–363.

Wilkes, R. E. 1995. Household life-cycle stages, transitions, and product expenditures. *Journal of Consumer Research* 22(1):27–42.

WITSA. 2004. *Digital planet: The global information economy.* Arlington, VA: World Information Technology and Services Alliance (WITSA).

Young, K. S. 1998. *Caught in the Net: How to recognize the signs of internet addiction—and a winning strategy for recovery.* New York: John Wiley & Sons.