December 2006

Technology Acceptance Model and Time: Understanding Formation in Beliefs through Training of Developers

Justin Cochran
University of Georgia

Saurabh Gupta
University of Georgia

Dale Goodhue
University of Georgia

Technology Acceptance Model and Time: Understanding Formation in Beliefs through Training of Developers

Justin Cochran
University of Georgia
justinc@uga.edu

Saurabh Gupta
University of Georgia
gupta@uga.edu

Dale L. Goodhue
University of Georgia
dgoodhue@uga.edu

ABSTRACT

Technology acceptance literature has primarily focused on the initial values and beliefs of end-users prior to technology adoption. However, recent research has shown that there is a change in these beliefs as users interact with the target system. This paper aims to address this gap by focusing on how beliefs change over time and how that change influences behavioral intention. Previous research has also been restricted to end-user applications and their adoption by novice users. However, to extend the generalizability of the model, we are examining TAM on a feature-level with IT professionals. More specifically, this research attempts to understand how TAM relates to user perceptions for a specific Java programming tool called Hashmaps. The paper outlines the theoretical basis for this research and describes the preliminary data collected thus far.

Keywords

Technology acceptance model, pre-adoption change in belief, programming, hashmaps, latent growth modeling,

INTRODUCTION

Technology adoption research is one of the most mature streams of research in information systems. Among the most prominent models in this area is the technology acceptance model (TAM) (Davis, 1989), which postulates two initial beliefs, perceived usefulness (PU) and perceived ease of use (PEOU), are the primary antecedents to an individual's adoption of technology. This paper uses TAM as its basis and aims to examine the model at a feature-level, both in terms of a closer examination of the development of the beliefs as well as the context in which the model is used.

In spite of the abundance of research regarding TAM (Lee, et al., 2003; Venkatesh, et al., 2005), the research has had its shortcomings. First, the research has primarily focused on describing the antecedents to behavioral intention. This understanding, although useful, does not give practitioners tools to influence these antecedents. Second, much of the TAM research has been restricted to end-user applications and its adoption by novice users (Lee et al., 2003). To further extend the boundaries of TAM, this research is intended to extend TAM in three primary ways. First, we study TAM at a feature-level. Second, we study TAM with a new group of users. Third, we use teaching interventions to understand how beliefs described by TAM change over time. Following is a description of these extensions in more detail.

Thus, the general question under investigation in this paper is: *How do interventions influence the development of perceived usefulness and perceived ease-of-use over time?* Such a question will not only enrich theory by enhancing our understanding of the development of these beliefs over time, it will also extend the generalizability of the model to a new context. For future analysis of collected data, we intend to employ latent growth modeling, a structural equation modeling variation which is useful for investigation of change variables.

EXTENDING THE TECHNOLOGY ACCEPTANCE MODEL

The Technology Acceptance Model (TAM) posits that an individual's behavioral intention (BI) to use a technology is based on the individual's perceptions about the usefulness and ease of use of the technology. In addition, the individual's intention to use directly impacts their actual usage behavior. A final relationship specified in TAM is that perceived ease of use

(PEOU) influences perceived usefulness (PU). The argument is that the easier to use a technology seems to be, the more useful the technology seems (Davis, 1989; Davis, et al., 1989). As previously mentioned, subsequent TAM research has been dominated by the search for antecedents to PEOU, PU, and BI (Lee et al., 2003).

Our first extension involves understanding if TAM fails at a feature-level. This is important because existing research has examined end users' beliefs about usefulness and ease of use for entire packages where they may have limited knowledge, understanding, and experience with all of the functionality included in the package. Therefore, there is opportunity for a disconnect between the measurement of user beliefs with incomplete understanding of the package's functionality and the measurement of their extrapolation of the entire package's usefulness, ease of use, and their intention to use. In other words, there may be an inconsistency between what is measured in reality (user beliefs about a fraction of the technology's functionality) and what is thought to be measured (user beliefs about the entire package). To study this, we are introducing a single programming tool and questioning subjects specifically about that tool, rather than the technology as a whole. Our expectation is that TAM will hold under this extension, but this boundary needs testing.

Our second extension is intended to address the tradition in TAM research to concentrate on end users. We recognize the need for this extension because end users are not the only user group of technology. Although developers are users of development tools, they are also designers for end user experiences. In fact, developers may potentially have three views of the ease of use and usefulness while developing software. First, the developer has the programming language technology, such as Java, HTML, or the .NET languages which provides the functionality being programmed. Second, the programmer has the programming interface, typically called the integrated development environment (IDE) which is a tool that often provides error-checking, compiling, and file management, among other things. Finally, the programmer has beliefs about the end user's perceptions of the functionality.

Stated differently, developers have beliefs about the "behind the scenes" technology that provides functionality to the end user, beliefs about their IDE, and beliefs about the end users perceptions of that functionality. For example, developers often have multiple options for creating functionality in software that the end user desires. Developers weigh these options, typically invisible to end users, in terms of ease of use and usefulness also. Thus, we believe a valuable extension of TAM will be to the developer user group.

Our third extension involves training interventions, which is an important component of systems development, but under-researched. More specifically, IS research has shown both the importance of training in computer skills (Compeau, et al., 1995) and the tendency of user beliefs about technology to change over time (Davis, 1989; Davis, et al., 2004; Karahanna, et al., 1999). We expect such a change to happen even in the pre-adoption stage. As shown in Figure 1, beliefs have a continued effect on the beliefs at the next phase. At this stage, participants are still forming their opinions regarding the technology. However, researchers have also argued that although perceived usefulness will increase as participants are exposed to more applications of the technique, the perceived ease of use will show a decline. Thus, we postulate that the vector of change over time will show a significant directional mean in the case of both antecedents.

H1: Perceived Usefulness (PU) will show a significant positive change over time

H2: Perceived Ease of Use (PEOU) will show a significant negative change over time

Research also suggests that as time moves on, participant's behavioral intention is more strongly determined by the utility of the technology rather than by its ease of use (Karahanna et al., 1999). Thus, we hypothesize:

H3: Over time, (a) the effect of perceived usefulness on behavioral intention will increase, while (b) the effect of perceived ease of use will decline.

Together these three hypotheses help us understand the how the development of belief happens over time and its consequent effect on behavioral intention.

RESEARCH DESIGN

To extend TAM in the aforementioned ways, we are using a three time period longitudinal study of novice Java programmers. The Java programmers are students in a junior level MIS classroom, most of whom have had little programming experience in general, and even less with Java. We feel this is a suitable sample for this particular extension of TAM because our interest is on developers that are receiving training in a systematic manner.

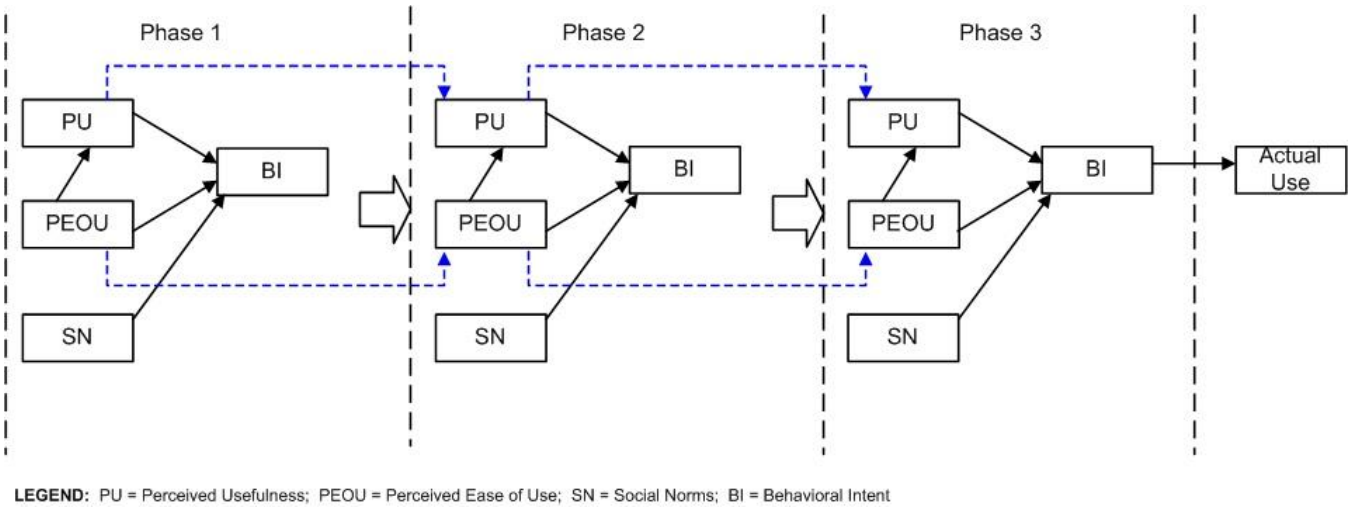

Figure 1: Conceptual Model

The research design for the study was a single group post-test only time-interrupted design (Cook, et al., 1979). The timeline of the research is as follows (Figure 2): Initially, the subjects have exposure to a collection class from Java called Arraylist. In the classroom, the subjects are taught an alternate collection class called hashmaps. At this point, it is not mentioned that a subsequent homework assignment will require the use of hashmaps[1]. Upon introduction to hashmaps, but before the hashmap assignment, the subjects are surveyed in the classroom, using an online survey tool, to measure the key constructs of TAM as they relate specifically to hashmaps. Additionally, the subjects are asked about their perceived voluntariness[2] and subjective norms with regard to hashmaps.

Next, the subjects were assigned a homework assignment requiring hashmaps for completion. Upon completion, the subjects were surveyed again about their perceptions of hashmaps. After several more weeks of additional Java training, the subjects are surveyed about their perceptions of hashmaps. Additionally, they are asked whether they intend to use hashmaps given a choice on the final exam. For the final exam, students are given an option to use hashmaps or another similar tool to complete a problem. The final data point measuring actual use is collected from the final exams. This allows us to address one of the common criticisms of previous research, self-reported usage (Lee et al., 2003).

Data was collected using common measures for TAM constructs (Karahanna et al., 1999; Venkatesh, et al., 2003). Each measure was adapted to refer specifically to hashmaps as the technology. Again, this is critical to the assessment of TAM at a feature-level. We are interested in user beliefs about a specific and narrow technology.

LIMITATIONS

This study was designed to improve both the internal and external validity of TAM by extending the theory at a finer level across a different user group. As a first step, the experiments have been deployed in a classroom environment. While our intention in deploying the experiments in a classroom environment is to increase internal validity, this sample might not reflect professionals receiving training in the real world. While we have plans to control for initial computer self-efficacy, student profiles (GPA, interest in this major, etc.), social norms, and voluntariness, our sample may have significantly different experience levels, beliefs about technology, and biases about being sampled.

[1] Due to time constraints, not every technique taught in the classroom is followed by a related homework assignment.

[2] Although subjects are not told of the coming hashmap assignment, we measure voluntariness, a common TAM construct which measures the user's perception that use is voluntary (Venkatesh, et al., 2000).

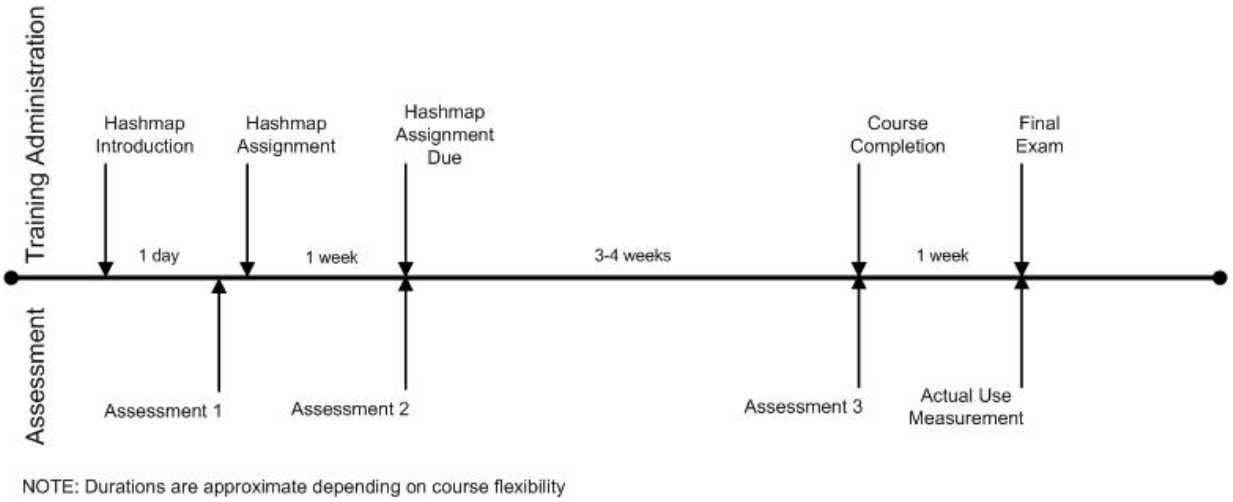

Figure 2: Study Timeline

CONCLUSIONS AND FUTURE RESEARCH

At this point, data collection is still underway. When enough data is available, this research will extend TAM in several key ways. The first extension is the study of TAM at a feature-level. Previous TAM research has been unclear about handling the potential disconnect between partial understanding of software functionality and assessment of the software as a whole. Second, this research extends TAM to a distinctly different group of users. Programmers or developers are expected to have more and different evaluations of technology because they are building systems for other end users. In other words, they are evaluating their own development tool, the programming language which provides the desired end user functionality, and their expectations of the end users' perceptions of the provided technology. The third extension of TAM is within the training context. It has long been suggested that over time, user beliefs about technology change. This research is an examination of how training influences these beliefs over time. An additional contribution is the illustration of a new analysis technique, latent growth modeling, that could prove very useful for the IS field.

REFERENCES

1. Compeau, D. R., and Higgins, C. A. (1995). Application of Social Cognitive Theory to Training for Computer Skills. *Information Systems Research* 6, 2, 118-143.
2. Cook, T. D., and Campbell, D. T. (1979). *Quasi-experimentation: Design and Analysis Issues for Field Settings*. Rand McNally College Pub. Co., Chicago.
3. Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly* 13, 3, 319-340.
4. 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, 8, 982-1003.
5. Davis, F. D., and Venkatesh, V. (2004). Toward Preprototype User Acceptance Testing of New Information Systems: Implications for Software Project Management. *IEEE Transactions on Engineering Management* 51, 1, 31-46.
6. 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.
7. Lance, C. E., Vandenberg, R. J., and Self, R. M. (2000). Latent Growth Models of Individual Change: The Case of Newcomer Adjustment. *Organizational Behavior and Human Decision Processes* 83, 1, 107-140.
8. Lee, Y., Kozar, K. A., and Larsen, K. R. T. (2003). The Technology Acceptance Model: Past, Present, and Future. *Communications of the Association for Information Systems* 12, 50, 752-780.
9. Venkatesh, V., and Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science* 46, 2, 186-204.
10. 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.
11. Venkatesh, V., Davis, F. D., and Morris, M. G. (2005). "Dead or Alive?: Future of Technology Adoption Research." Paper presented at the Gordon B. Davis Symposium, Minneapolis, Minnesota.