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ABSTRACT

This study is the second step of a long-term research project, which investigates the innovative uses of a software application by adolescents in an all girls' high school in the southern United States. In the first phase, we proposed a research model that can be used to predict innovative use following mandatory adoption by conducting surveys and quantitative analysis of the results (Singletary et al. 2002a, 2002b). In this second phase, we will more deeply investigate innovative use phenomenon through qualitative analysis using cognitive mapping methodology. The current study is based in large part on Social Cognitive Theory (Bandura 1986; Wood and Bandura, 1989). We will also utilize the Diffusion of Innovations Theory (Rogers, 1995) and the Task-Technology Fit Theory (Goodhue and Thompson, 1995).

Keywords

Cognitive mapping, innovative use, technology acceptance and use, high school students

INTRODUCTION

This study augments an early study that investigated the innovative uses of a software application by adolescents in an all girls' high school in the southern United States. Four years ago, this high school developed a unique educational environment totally immersed in information technology (IT). As part of the technology immersion curriculum, all incoming freshmen are provided with laptop computers connected via wireless technology and all teachers are evaluated based on the degree of technology immersion in their class activities and lesson plans (Singletary et al., 2002a). The high school provides training and workshop sessions in the summer for teachers to assist them in learning new technologies and more effectively integrate IT into their classes.

While totally revamping the curriculum to most effectively utilize IT, the main goals of the administrators were to strengthen the curriculum, enhance the instructional process and raise the level of student learning and performance. The initiative has begun bearing fruit both in anticipated and unanticipated ways. As a part of the new technology immersion curriculum, the high school began requiring the use of Geometer's Sketchpad®[1] software as part of the 9th or 10th grade geometry classes. Teachers began to observe that some students started voluntarily extending their use of the tool to other classes and to non-school related tasks.

For the purposes of our studies, we defined "innovative use" as the act of "voluntarily expanding the use of a software application to new tasks and new settings after mandatory adoption for a specific task in a specific setting." Research suggests that an innovation might refer to an idea, practice, or an object that an individual perceives as being new. Therefore, an innovation need not necessarily refer to a technology; it may also refer to a renewal in terms of thought and action (Rogers, 1995; Thong, 1999). The boundaries of an innovation may not be very distinct. Potential adopters may perceive an innovation as being highly related to another new idea or a bundle of new ideas. Consequently, we believe that, for research purposes, it is possible to view extended use of software after mandatory adoption as "innovative use" (see Table 1).

[1] ***Geometer's Sketchpad*** ® is a registered trademark of Key Curriculum Press

	Class activities	**Non-Class activities**
Geometry	Mandatory	Not observed
Non-geometry	*Voluntary use related to non-geometry topics (i.e., Biology, Fine Arts)**	*Voluntary use for tasks outside of school (i.e. landscape design, room design)**

**Italics indicates "innovative use" situations*

Table 1. Mandatory-Innovative Use Matrix

The main purpose of this second phase of the study is to understand why some of the students voluntarily extended the use of the software to other classes, other activities and other tasks unrelated to Geometry. We will investigate how some of the students came up with the idea of extending the use of software (the antecedents of extended use). Moreover, we will explore the differences between innovative users and non-innovative users, as this might help identify factors that facilitate or inhibit innovative usage and the relative importance of such factors. We will also investigate the role of friends, family and teachers on the innovative use. We will look at the differences between the first "innovative" users verses the "copycats"–the ones who got the idea after observing or learning about the innovative use from other students. In addition, we will investigate if there are students who attempted innovative use but abandoned it and why.

THEORETICAL BACKGROUND

A number of theoretical models have been used to investigate the determinants of information systems usage. Among these models intention-based theories such as Theory of Reasoned Action (Fishbein and Ajzen, 1975), Theory of Planned Behavior (Ajzen, 1991), and Technology Acceptance Models (Davis et al., 1989; Venkatesh and Davis, 2000), have been widely utilized by IS researchers. In the first phase of our study we proposed a research model utilizing these theories. These theories suggest that behavior (IT usage) is determined by intentions, which in turn is determined by the beliefs and attitudes towards IT (Taylor and Todd, 1995). On the other hand, as opposed to intention-based theories, theories in the psychology literature such as Social Cognitive Theory (-SCT- Bandura 1986; Wood and Bandura, 1989) argue that user behaviors might also affect user attitude formation. Consequences of a behavior in turn lead to forming expectations of behavioral outcomes. Since this study investigates innovative uses of a software application by students after they have been required to use that software as part of their normal Geometry class, it is important to look at both attitude-behavior and behavior-attitude relationships. In this second phase of our study we will focus on behavior-attitude relationships.

Based on SCT, we believe that the consequences of mandatory usage behavior will lead to forming expectations of voluntary extended usage outcomes, which will in turn affect the students' innovative usage of the software application. SCT states that personal factors, environmental events and behavior interact with each other bi-directionally over time and in turn determine human behavior (Bandura, 1986). Personal factors such as personal innovativeness, cognitive style, personality, self-efficacy, may influence software use (Agarwal and Prasad, 1998; Compeau and Higgins 1995; Hill, et al. 1987). Dillon and Morris (1996) demonstrate that early adopters posses personality traits such as risk taking, and adventure seeking that distinguish them from individuals that are in other categories. In addition, environmental factors such as technologically advanced facilities, peers, family, and teachers can facilitate or inhibit innovative use.

Moreover, students can form perceptions based on the characteristics of the software such as relative advantage, compatibility, complexity, observability, and triability, etc. Diffusion of innovations research (Rogers, 1995) studies the characteristics of IT as the most important determinants of adoption and usage, and can provide important insights into our research.

Finally, the task-technology fit literature (Goodhue and Thompson, 1995) looks at the match between the requirements of the task and the features of the IT to explain the utilization of the IT and performance outcomes. The features provided by Geometer's Sketchpad® and the tasks the students plan to perform should fit so that the students would consider using Sketchpad® to perform those tasks. Moreover, the use of the software in geometry class will lead to performance outcomes. These performance outcomes might in turn have an affect on students' forming expectations about the performance outcomes of the usage of software in other areas. These expectations might facilitate or inhibit innovative use.

RESEARCH METHODOLOGY

In this study we will use cognitive mapping technique as the main data collection and analysis method. Tolman (1948) defines a cognitive map as a "mental model, which allows a particular problem domain to be framed and simplified so that it can be understood" (cf. Swan and Newell, 1998, p. 125). Cognitive maps assist in externalizing human internal presentations, in uncovering the relationships among these presentations (Eden and Spender, 1998) and in visually representing both the presentations and the relationships between them. Causal maps assume that, "(1) causal associations are the major way in which understanding about the world is organized, (2) causality is the primary form of post hoc explanation of events, and (3) choice among alternative actions involves causal evaluations" (Huff, 1990, p.28).

There are several different cognitive mapping techniques that can be used by a researcher based on the context of the investigation (Huff, 1990). These different types include maps that reveal causal relationships (A causes B), which are commonly used in organization theory, strategic management, and political science research (Huff, 1990). We plan to utilize this type of cognitive map for our study. See Figure 1 for a partial example of a cognitive map for this research domain.

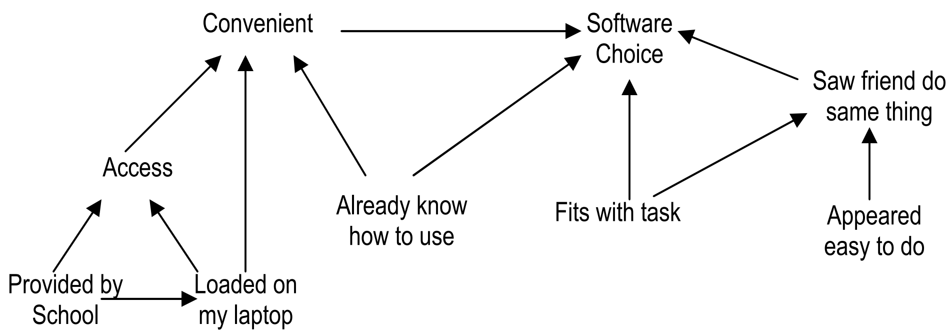

Figure 1. Partial Example of a Cognitive Map

We will collect the data in focus groups and interviews. The cognitive maps will be created during interviews and updated after the interviews with a cognitive mapping software package (Decision Explorer). A composite cognitive map for the entire sample will be generated from the individual maps. We will interview the students who have voluntarily expanded their use of the software application to other classes or to non-school related activities. In addition, we will interview students who have limited their use only to Geometry. We will conduct a few individual interviews, but most of the data will be collected in small groups. Kelly (1955) states that cognitive mapping can be used with individuals on a one-on-one basis or it can be used with small groups. Special emphasis has been given to the preparation of interview questions, which are available from the authors upon request. Questions are drawn from our reference literature (mentioned above) supplemented with the results from the survey performed in phase one of this research project. Students will create the causal maps using a drawing software package (Inspiration) that they frequently use in their classes to map causal relationships between events. Two researchers will facilitate the process and ask the interview questions. A third researcher will independently map the ideas expressed by the students during the interview process. The students will be organized in relatively homogeneous groups with respect to their level of innovated use of Geometer's Sketchpad®. This information was captured in the phase one survey and we will also solicit the opinions of teachers in classifying students. Initially, we will only have two groups, students who only use the software in Geometry and students who use the software both in Geometry and outside of Geometry.

Cognitive maps of the two groups of the students will be compared. Eden and Ackerman (1998) state that a cognitive map comparison across industries, countries, between individuals or between groups is a common strategy. Comparing the maps of students who voluntarily extended the use of software to those who have not will help us understand the differences between these groups. We believe that this understanding can be used to develop strategies to encourage all students to increase their experimentation and expanded use of information technology. An interesting extension of the study will be to compare the before and after cognitive maps of the students once these encouragement strategies are in place. Eden and Ackerman (1998) state that this type of comparison can be provide invaluable insights for instructional practices. Based on our findings, we will develop a preliminary set of strategies that could be used by educators to encourage students to explore new and creative ways of using software applications as part of their mission to encourage creative problem solving abilities of their students, and then test the effectiveness of these strategies on students.

CONCLUDING REMARKS

Increasingly, information technologies are being incorporated into high school curriculums. As technology becomes an important part of education and daily life, educators find that they are called upon not only to teach raw information but also to encourage self-directive or active learning, creative thinking and creative problem solving. Therefore, understanding the factors that affect unanticipated and voluntary extended usage behavior of students can help educators to design strategies to produce more active learners who use their minds and intuitions effectively when performing complex and meaningful tasks not only in a classroom setting but also in daily life. We believe the findings of our study can be used by educational intuitions to provide a richer learning environment for students, enhance the curriculum and the instructional process, and ultimately raise the level of student learning and performance.

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