



JOURNAL OF  
INFORMATICS EDUCATION RESEARCH

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*Journal of Informatics Education Research* • Spring 2007 • Volume 9, Number 1

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ISSN: 1526-4726

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# **USER ACCEPTANCE OF CASE TOOLS IN SYSTEMS ANALYSIS AND DESIGN: AN EMPIRICAL STUDY**

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## **ABSTRACT**

Computer Aided Software Engineering (CASE) consists of a set of tools that support automation of various software engineering processes. CASE is extensively used by software developers in industry in systems analysis and design due to gains it provides in productivity and improved documentation quality. Studies indicate that with the proliferation of information technology in today's organizations and the capital investments required that users must use and accept technology to improve productivity. In this study we examine the determinants of CASE tool acceptance and use. We simulate a systems development environment in a classroom and examine the determinants of CASE tool use. We use the Unified Theory of Acceptance and Use of Technology (UTAUT) model to identify and test core determinants of user intention to use these tools. Data was collected and analyzed from 85 students regarding their use of CASE technology in the classroom. Results show partial support for the UTAUT in that participants' performance expectancy and social influence affect behavioral intention to use CASE tools while effort expectancy did not. Results also show that facilitating conditions, computer anxiety and attitude toward using technology have an effect on intention to use CASE tools. Considering the substantial investment required to acquire CASE tools, we

believe our findings on the determinates of CASE tool acceptance are important both to industry in the use of CASE and to universities in teaching with CASE.

**Keywords:** Computer Aided Software Engineering, CASE Tools, UTAUT model, technology acceptance

## I. INTRODUCTION

Computer Aided Software Engineering (CASE) consists of a set of tools that support automation of various software engineering processes. Software developers in some organizations use CASE tools in systems analysis and design to produce the various models required by different development methodologies. Research points to productivity gains from CASE analysis and design tool usage [Tsuda, 1992] and reduction in personnel requirements and system development costs [LeBlanc and Korn, 1992] in system development. CASE tools have become integral part of organizations that are interested in improving their process maturity level [Goldenson and White, 2000; Wittman, 1995]. Some recent examples where CASE tools have been widely used in practice were reported by Berenbach [2006], Brambilla [2006], Lange, Chaudron, and Muskens [2006], and Sriplakich, Blanc, and Gervais [2006].

Some universities have followed the lead of the software industry by incorporating CASE tools in their course offerings, for examples, see Bothe, Schutzler, Budimac and Zdravkova [2005] and Diethelm, Geiger and Zundorf [2005]. A detailed description on contemporary usage levels of CASE tools in U.S. colleges and universities is provided by Chinn, Lloyd, and Kyper [2005]. As evident in a recent proposed model for information technology curriculum [Ekstrom et al., 2006], the use of CASE tools in universities will continue at least in the near future. It is believed that the use of a CASE tool improves student understanding of systems development concepts and also provides them with a skill that may be considered valuable in the job market. Industry greatly benefits from having students gain experience in the use of CASE tools within their university program. It enables the organization to more easily assimilate

graduates into the system development process. In addition, the academic CASE experience is valuable since many industries want and need students with CASE competencies. It is also safe to assume that the experience of students with a particular technology might influence their use of that technology later on the job.

The focus of this study is to evaluate the use of CASE tools in systems analysis and design; to be more specific we examine factors that influence the use of CASE in a systems development environment. We simulate a systems development environment in a classroom and examine the determinants of CASE tool use. We use the Unified Theory of Acceptance and Use of Technology (UTAUT) model proposed by Venkatesh, Morris, Davis, and Davis [2003] to identify and test core determinants of user intention to use these tools. An examination and acceptance of CASE tools is important to both the industry and academic departments that have either integrated or are contemplating integration of such tools due to the substantial investment required to procure such tools.

Our paper is organized as follows. We present our literature review next. Here we report on research on CASE tools in the software industry, CASE tools in education, and then provide an overview of the UTAUT. After the literature review we present our research model followed by the research methodology. Finally, we present the results and conclusion.

## **LITERATURE REVIEW**

The literature review covers the three research areas of interest to our study: research on CASE tools in the software industry, research on CASE tools in education, and the model for technology acceptance and use. In the pages that follow, we consider each of the research areas separately.

### **CASE tools in the Software Industry**

CASE is considered to be a technology that includes a diverse range of automated products to assist in system development tasks. CASE software has

been defined as “meta-software”, software used to develop software [Perrone and Potter, 1992]. Many organizations in the late 80s turned to CASE tools as a promising technology to increase productivity and quality of software development. Some even thought that CASE would replace the programmer with code generation capability that certain tools possess. Recently, there has been recognition that CASE is not the panacea for all software development problems and that it represents only one factor in improving the software development effort and the quality of software [Blackburn, Scudder, and Van Wassenhove, 2000]. CASE is sometimes viewed as a supporting technology that aids in the efficient development and maintenance of software. Currently, there are many CASE products on the market that range from standalone tools that automate specific life cycle tasks to integrated environments that automate most life cycle tasks [see Lange et al., 2006, and Sriplakich et al., 2006].

When examining the use of CASE tools in the software industry, the literature tends to focus on three primary areas. The first discusses how CASE tools provide value to the industry. The second area examines the reasons for use or non-use or reasons for failure of CASE tools in some organizations. The third discusses how CASE can be used to aid in improving corporate Capability Maturity Model (CMM) ratings [Wittman, 1995]. Research points to productivity gains from CASE analysis and design tool [Tsuda, 1992]. CASE was also found to provide value by enforcing development standards and constraints specified by methodologies on software developers. Although such constraints frustrate designers and may limit their freedom to modify methodologies to suit their preferences, abilities, and circumstances, they benefit in ensuring that designs conform to a development methodology and to notation standards [Scott, 2000]. Some found benefits in using CASE in specific, focused areas such code production or testing [Sharma and Rai, 2000].

Although CASE provides valuable benefits, there are also problems that impede the adoption of CASE tools within organizations. One problem is that the

current method-centered CASE tools are not attractive enough to the users. To better contribute to the software development practice, CASE tools must be more user oriented, and support creative problem-solving aspects of software development as well as rigorous modeling [Jarzabek and Huang, 1998]. Another reason for the infrequent use of CASE has been attributed to the lack of support for work groups [Vessey and Sravanapudi, 1995] and the perception of high complexity to train and use [Livari, 1996]. This perception of complexity is relevant as it makes it difficult to appreciate the advantages of CASE. Therefore, any intervention that can change these perceptions can be expected to be significant in the adoption of CASE tools and may be a factor in influencing the intention to use. CASE training should also pay more attention to the significance of perceived complexity in CASE adoption. It is important to devise strategies in which the perceived complexity is under scrutiny all the time.

Lending and Chervany [1998] provided an interesting insight on the use of CASE tools by developers in industry by identifying reasons for non-use. The study addressed use of CASE tools, features most used, enjoyment using them and their perceived usefulness. The study concluded that developers who follow a formal methodology tend to use CASE tools more. Motivation is another factor that influences use. One conclusion of the study was that if a tool is enjoyable to use, it is more of a motivation to use the tool than the advanced features it may have. This motivation would more likely help organizations to achieve the benefits of using CASE tools. Cost is another problem impeding the adoption of CASE. Many organizations have found the costs of adopting CASE tools tend to exceed their original estimates [Huff, 1992]. These unanticipated costs may lead management to terminate a promising CASE tool project or may increase resistance to future CASE tool acquisitions. However, if management believes that CASE technologies will be used and accepted by users to improve productivity, the investment may be justified. Other factors that encourage adoption include the existence of a product champion, strong top management

support, and the perception that CASE technology has advantages [Premkumar and Potter, 1995].

In trying to understand the reason that CASE tools seem to be dearly bought but sparsely used, Huang [1998] pointed out that based on practical experience, CASE tools are not user-oriented, and that CASE users have not been given enough consideration in the production of CASE tools. Today's CASE tools are motivated by new paradigms and techniques in the area of software engineering; therefore, makers of CASE tools are often driven by techniques, rather than by real users' needs and expectations. Some suggested strategies for building CASE tools include modeling users' behaviors and incorporating knowledge about users, domains, methodologies and techniques in the next generation CASE tools. According to LeBlanc and Korn [1992] CASE tools for application development will reduce personnel requirements and system development costs. However, the less than expected performance of CASE may be explained by weak or non-existent selection procedures.

The third area on using CASE tools in industry discusses how CASE can be used to aid in improving corporate Capability Maturity Model (CMM) level. The CMM, a product of Carnegie Mellon's Software Engineering Institute is a framework that describes the key elements of an effective software process to achieve the production of higher quality software. The CMM framework which characterizes organizations by their maturity, consists of five maturity levels starting with level 1 (Initial), where few formal processes exist, to level 5 (Optimized), where quantitative feedback is used for continuous process improvement. Of interest to this research is CMM level 3 (Defined) and CMM level 4 (Managed). CMM level 3 is characterized by an organizational commitment (focus) to software process development and software engineering methods and tools that are applied consistently to projects. Level 4 involves the collection of detailed measures of software process and product quality. CASE tools enforce rigid methods and standards that are important components of a

process improvement program [Goldenson and White, 2000; Mathiassen and Sorensen, 1994; Wittman, 1995]. Organizations focused on improving their maturity level have implemented CASE tools that range from debuggers and code producers to error tracking and reporting database applications. CASE tools fit well within the Level 3 process of identification and utilization of software engineering technologies and methods. They are also integral to their move to a level 4 software process. By identifying and establishing measurements of the relevant data being recorded they can begin to optimize their software processes [Wittman, 1995]. Managing the introduction of CASE in such organizations requires knowledge of how the specific characteristics of CASE technology influence CASE introduction, how the organizational environment influence CASE introduction and defining the role of organizational experiments in CASE introduction [Mathiassen and Sorensen, 1994]. As previously stated, a significant proportion of software-mature organizations use CASE as a standard practice [Goldenson and White, 2000].

To summarize, research indicates that the selection of appropriate tools and the effective use of CASE technology are critical for systems development success in organizations. CASE is still viewed by some as a technology that plays an important role within organizations that are involved in the development, deployment and maintenance of large software-intensive systems. The demand for software engineers with formal training in the use of CASE tools warrants educators to incorporate CASE tools into the curriculum at the undergraduate and graduate levels to prepare their students for careers in the software industry.

### **Research on CASE Tools in Education**

Adoption and use of CASE tools in the software industry enhanced the interest of educators in introducing them in the classroom. Integrating CASE tools into the curriculum continues to be of interest to educators and the industry due to the potential benefits in enhancing student learning experiences and preparing them for work in the IS field [Granger and Little, 1996]. Students who

learn how to use CASE tools within their university program can easily transfer their skills to software environments within organizations that use CASE tools. Professional organizations such as ACM, AIS, and AITP have developed model information systems curricula which include courses where CASE tools can be used. Some of the courses described include generic systems analysis (structured and OO), system design (structured and OO), database systems, project management, and integrative capstone courses focused on system design projects that integrate concepts learned in other technical courses.

One of the early studies discussed the experience of integrating CASE into Computer Science undergraduate education at the University of British Columbia [Jeffrey, 1999]. The author reported on the objectives of the initiative, the tools that were used, the implementation and difficulties encountered. Overall, the initiative was challenging but rewarding to both instructors and students who had a positive learning experience. Some of the reasons stated for the integration of CASE tools were to provide students with new skills for careers in the industry, to make them aware of CASE tools as a new technology and to prepare them for research in the area. Other studies examine the appropriate time at which CASE tools should be introduced, the benefits of enforcing standardization and the relevance of CASE tools in learning software development methods in a university setting [Eriksen and Stage, 1998]. At Bentley College, by providing CASE tools to students who study systems analysis and design, students were able to handle projects of greater difficulty after switching to modeling and analysis using CASE tools. It was also easier for students to learn design concepts [Derringer, 1995]. Granger and Pick [1991] reported reduced time in completing a design and coding project by students using a CASE tool compared to those who did not.

Mynatt and Leventhal [1990] assessed the impact of the use of CASE in an undergraduate software engineering course on student attitudes and found that CASE can be a significant enhancement. The attitudes of students using

CASE tools were positive and the quality of their work appeared to be better compared to those in which CASE was not used. The following are some of the commonly cited benefits mentioned for the use of CASE in the classroom [Mynatt and Leventhal, 1989]:

- Enforcement of the standards and the rules of the methodology taught in the class. This can be a great benefit to students who are learning to ensure that their designs conform to a development methodology and to a notation.
- Enhancing team communication on team projects. Communication both between the developer and the customer and among developers working on a project results in improved quality of deliverables.
- Enhancement of the quality of student projects through the standardization and automatic checks provided.
- Improvement in the quality of documentation and the capability of CASE tools to create a repository of documentation for the project.
- CASE allows the students to focus on the more important concepts and on creativity since it handles the tedious clerical and mundane manual tasks.
- Providing hands-on experience with a leading edge technology that is used in the software industry.

Recent articles address the competitive global environment and the need to incorporate CASE tools into the curriculum since it is considered one of the new technologies [Rollier, 2002]. Although there is an increased interest in the software industry in the object oriented methodologies, only one article addressed the need to include a CASE tool as a component of an OO curriculum to mirror the OO technologies currently being used for OO development [Douglas and Hardgrave, 2000].

Considering the perceived benefits of CASE tools and its adoption in the classroom, many CASE vendors are providing educational versions of their

software at affordable prices to students. Some publishers are bundling CASE products with textbooks so that they can be used by students in their courses. Some vendors such as Microsoft, are forming partnerships with universities where their software is provided free to students registered in IS courses. Many universities are providing full versions of CASE software in their computer labs. Examples of commonly used CASE tools at universities are Visible Analyst, System Architect, Visio and Rational Rose. Considering the investments in resources and time required to integrate CASE into the curriculum, it is necessary to determine its acceptance and use by students.

### **Technology Acceptance and UTAUT Model**

Studies indicate that with the proliferation of information technology in today's organizations and the capital investments required, organizations believe that technologies must be used and accepted by users to improve productivity [Igbaria et al., 1997]. This led to the development of several theoretical technology acceptance models which were rooted in information systems, psychology and sociology to explain user intention and acceptance of new technology. A well known and popular model, the Technology Acceptance Model (TAM), was used in several studies to determine user acceptance [Davis, 1989]. "The goal of TAM is to provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behavior across a broad range of end-user computing technologies and user populations..." [Davis 1989, p. 985]. In the original TAM, Davis proposed that perceived ease of use and perceived usefulness are two factors that influence an individual's intention to a technology, and this in turn affects actual use. Davis also mentioned that there are some external variables that can affect perceived ease of use and perceived usefulness. The TAM has been validated by a number of studies. Adams, Nelson, and Todd [1992] validated TAM by using it to examine users' acceptance of voice mail and electronic mail. Szajna [1996] revalidated the model using a longitudinal study of email use by graduate students. TAM has also been used

to evaluate user acceptance of other technologies, such as, electronic commerce [Keat and Mohan, 2004] and electronic learning [Ong et al., 2004].

Over the years researchers have extended the original TAM by adding external variables that influence ease of use and perceived usefulness. Venkatesh and Davis [2000] added independent variables such as subjective norm, image, job relevance, job quality, and result demonstrability to the TAM and called the revised model TAM2. Other variables that have been identified as external variables in the model include intrinsic motivation [Venkatesh, 1999], computer self-efficacy, objective usability, and experience [Venkatesh and Davis, 1996], and perceived system quality, individual's work load and prior performance [Lucas and Spitler, 1999]. Although TAM has been validated, tested and even extended in the past decade and half, other technology acceptance models have also been proposed, including the Theory of Planned Behavior [Ajzen, 1991]. The extensive use of TAM, as well as these other models, led to the creation of new integrated or unified model of technology acceptance that we use in our study.

One of the latest technology acceptance models, the Unified Theory of Acceptance and Use of Technology (UTAUT) synthesized elements across eight well known technology acceptance models to achieve a unified view of user acceptance [Venkatesh et al., 2003]. The eight models are: the theory of reasoned action (TRA), the technology acceptance model (TAM), the motivational model (MM), the theory of planned behavior (TPB), the combined TAM and TPB, the model of PC utilization (MPTU), the innovation diffusion theory (IDT) and the social cognitive theory (SCT). The resulting unified UTAUT model consists of four core components or determinants of intention and usage (these are described later). The model is claimed to be a useful tool for managers to assess the likelihood of acceptance of a new technology within an organization. It also helps in understanding factors that drive acceptance of a new technology, so that appropriate features can be designed to facilitate

acceptance of a new technology by users.

## II. THE RESEARCH MODEL

In the previous section we identified research in the use of CASE tools in industry and universities, and reviewed research on the acceptance of technology. We draw on our literature review to present a research model to investigate the user acceptance of CASE tools in a systems development environment. We use the Unified Theory of Acceptance and Use of Technology (UTAUT) proposed by Venkatesh et al. [2003] to understand the use of CASE tools. The UTAUT identified seven factors that influence use of information technology. They are: performance expectancy, effort expectancy, attitude toward using technology, social influence, facilitating conditions, self-efficacy, and anxiety. Definitions for each of these factors influencing information technology use are provided in Table 1. Please note that we are using the terms information technology and system interchangeably.

Table 1. Definitions of Determinants of Acceptance and Use of Technology\*

Determinant	Definition
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.
Effort Expectancy	The degree of ease associated with the use of the system.
Social Influence	The degree to which an individual perceives that important others believe he or she should use the new system.
Facilitating Conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.
Self-Efficacy	Judgment of one's ability to use a technology to accomplish a particular job or task.
Attitude	Attitude toward using technology is defined as an individual's overall affective reaction to using the system.
Anxiety	Evoking anxious or emotional reactions when it comes to performing a behavior.

\*These are the original definitions provided by Venkatesh et al. [2003].

The dependent variables in the original UTAUT model proposed by Venkatesh et al. [2003] were intention to use the system and actual use. In their research model, Venkatesh et al. [2003] expected only four factors to have a

significant effect on user acceptance and usage behavior. The factors in this category were: performance expectancy, effort expectancy, social influence and facilitating conditions. The other three, attitude toward using technology, self-efficacy, and anxiety were theorized not to be direct determinants of the intention to use the system. A number of moderators were also identified, they included, gender, age, voluntariness, and experience.

In our research, we focused our attention only on the behavioral intention to use since the primary concern of this study is to examine factors that influence students' intentions in their future use of CASE tools and not necessarily the testing of the entire UTAUT model itself. Such decision is supported by the original results found by Venkatesh et al. [2003] in which usage intention is the only significant determinant for actual use over a longitudinal study; another example of a study where behavioral intention is the final dependent variable, not the behavior, is one conducted by Bock, Zmud, Kim, and Lee [2005]. Furthermore, behavioral intention has already been widely accepted to as a predictor of actual behavior in the IS field and reference disciplines [Ajzen, 1991; Sheppard et al., 1988; Taylor and Todd, 1995]. Figure 1 provides a graphical representation of our research model. Here we have identified the four determinants of behavioral intention to use based on the original UTAUT model. Since we were evaluating the use of CASE tools in the classroom where most students are more or less in the same age group, we did not include age as a moderating variable. We also dropped voluntariness of use from the UTAUT model because use of CASE tools was voluntary for students.

Our hypotheses are based on the original UTAUT model [Venkatesh et al., 2003]. We have modified the hypotheses based on the variables that we have in our model. The following are our proposed hypotheses:

H1: The influence of performance expectancy on behavioral intention will be moderated by gender.

H2: The influence of effort expectancy on behavioral intention will be moderated by gender and experience.

H3: The influence of social influence on behavioral intention will be moderated by gender and experience.

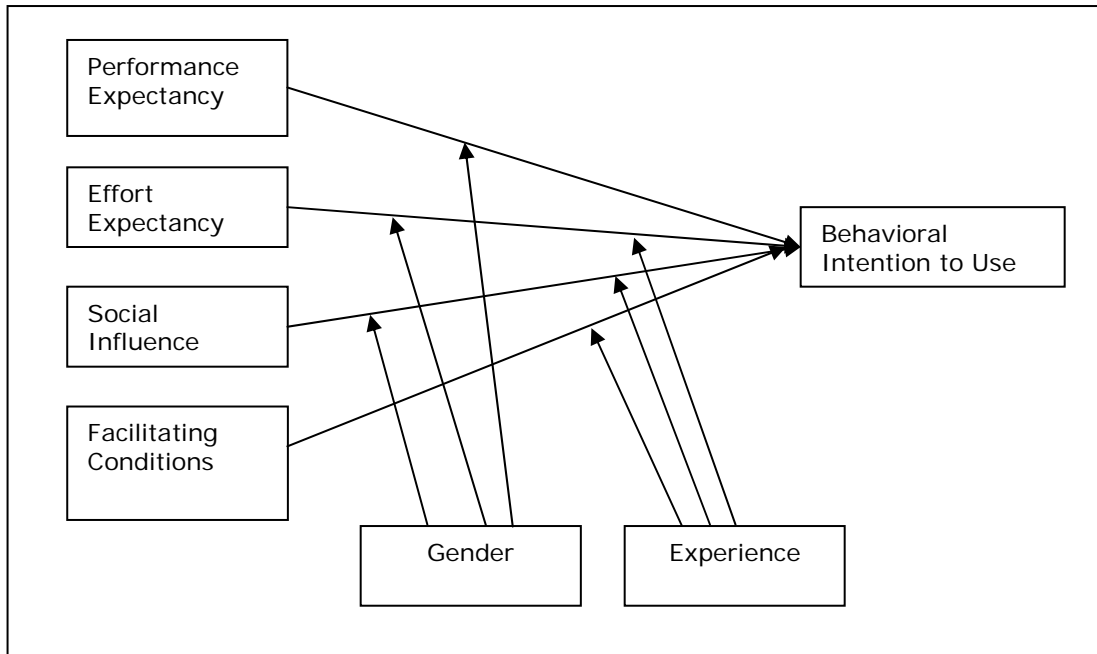


Figure 1. The Research Model

In addition to the hypotheses above, the UTAUT model also proposed that some of the factors including facilitating conditions, computer self-efficacy, computer anxiety and attitude towards using technology will not have a significant influence on behavioral intention to use the technology. Therefore, we state the next four hypotheses as follows:

H4: Facilitating conditions will not have a significant influence on behavioral intention.

H5: Computer self-efficacy will not have a significant influence on behavioral intention.

H6: Computer anxiety will not have a significant influence on behavioral intention.

H7: Attitude toward using technology will not have a significant influence on behavioral intention.

In this section we have proposed our research model and hypotheses. The UTAUT provides the theoretical underpinnings of our study. We utilize the UTAUT model to examine the role of the factors identified in the model on the acceptance of CASE tool technology in a systems development environment. In the following section we describe our research methodology including the sample, data collection and analysis.

### **III. METHODOLOGY**

#### **SAMPLE**

The sample for our study consisted of students in the undergraduate and graduate information systems program at a large mid-Atlantic university in the United States. These were students who were taking courses in systems development or database design. CASE tools provide valuable diagramming abilities that are especially useful in representing information systems components during analysis and design. Use of the CASE tool was voluntary for undergraduate and graduate students in this study. Undergraduate students had a separate laboratory assigned for the course which would meet once every week in addition to a lecture class. Here students were given preliminary instruction on the use of the CASE tool. The students then solved problems and exercises using the tool. At the graduate level, students were given privileges to download CASE tool applications from the departmental server and use it on their own. Students, both undergraduate and graduate, had a project requirement in the course. The project was a real-life case from an organization where the students, as systems analysts, had to analyze an existing system that had problems and design a new and improved information system. The project accounted for at least 25 per cent of a student's grade for the course. It was in this section of the course requirement where CASE tools were primarily used in the course. This project requirement created a systems development environment similar to those found in real organizations.

## Sample Characteristics

Our sample consisted of 85 students. Descriptive statistics for our sample are provided in Table 2 through Table 5. Nearly 60 percent of students were male (see Table 2) and almost half of all students had one to five years of work experience (Table 3). Three-quarters of the students were in a graduate class (Table 4) while most students used Microsoft Visio as the CASE tool (Table 5). In the next section we report on how we collected data.

Table 2. Sample Characteristics – Gender

Gender	Frequency	Percent
Female	35	41.67
Male	49	58.33
Total	84*	100.00

\*Missing values = 1

Table 3. Work Experience

Number of Years	Frequency	Percent
Less than 1 year	20	24.39
1 to 5 years	38	46.34
5 to 10 years	10	12.20
10 years or more	14	17.07
Total	82*	100.00

\*Missing values = 3

Table 4. Course Level

Course Level	Frequency	Percent
Undergraduate	23	27.06
Graduate	62	72.94
Total	85	100.00

Table 5. CASE Tool Used

CASE Tool	Frequency	Percent
Visible Analyst	13	15.29
Microsoft Visio	72	84.71
Total	85	100.00

Table 6. Questionnaire Items

<p>Performance Expectancy Items</p> <ol style="list-style-type: none"><li>1. I find the CASE tool useful in my course.</li><li>2. Using the CASE tool enables me to accomplish tasks more quickly.</li><li>3. Using the CASE tool increases my productivity.</li><li>4. If I use the CASE tool, I increase my chances of getting a good grade</li></ol> <p>Effort Expectancy Items</p> <ol style="list-style-type: none"><li>5. My interaction with the CASE tool is clear and understandable.</li><li>6. It would be easy for me to become skillful at using the CASE tool.</li><li>7. I find the CASE tool easy to use.</li><li>8. Learning to operate the CASE tool is easy for me.</li></ol> <p>Attitude Items</p> <ol style="list-style-type: none"><li>9. Using the CASE tool is a good idea.</li><li>10. The CASE tool makes work more interesting.</li><li>11. Working with the CASE tool is fun.</li><li>12. I like working with the CASE tool.</li></ol> <p>Social Influence Items</p> <ol style="list-style-type: none"><li>13. People who influence my behavior think that I should use the CASE tool.</li><li>14. People who are important to me think that I should use the CASE tool.</li><li>15. The senior management and faculty of the university have been helpful in the use of the CASE tool.</li><li>16. In general, the university has supported use of the CASE tool.</li></ol> <p>Facilitating Conditions Items</p> <ol style="list-style-type: none"><li>17. I have the resources necessary to use the CASE tool.</li><li>18. I have the knowledge necessary to use the CASE tool.</li><li>19. The CASE tool is not compatible with other systems I use.</li><li>20. A specific person (or group) is available for assistance with CASE tool difficulties.</li></ol> <p>Anxiety Items</p> <ol style="list-style-type: none"><li>21. I feel apprehensive about using the CASE tool.</li><li>22. It scares me to think that I could lose a lot of information using the CASE tool by hitting the wrong key.</li><li>23. I hesitate to use the CASE tool for fear of making mistakes I cannot correct.</li><li>24. The CASE tool is somewhat intimidating to me.</li></ol> <p>Behavioral Intentions Items</p> <ol style="list-style-type: none"><li>25. I intend to use the CASE tool in the next two semesters.</li><li>26. I predict I would use the CASE tool in the next two semesters.</li><li>27. I plan to use the CASE tool in the next two semesters.</li></ol> <p>Self-Efficacy Items</p> <p>I could complete a job or task using the CASE tool if...</p> <ol style="list-style-type: none"><li>28. There is no one around to tell me what to do as I go.</li><li>29. I could call someone for help if I got stuck.</li><li>30. I had a lot of time to complete the job for which the software was provided.</li><li>31. I had just the built-in help facility for assistance.</li></ol>
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### Data Collection

Data was collected using a questionnaire to test the research model in our

study. Since the UTAUT model is used to study acceptance/use of CASE technology in the classroom, we used the questionnaire developed by Venkatesh et al. [2003] in their original study; the original questionnaire was modified to identify the CASE tool as the subject of the questionnaire. In addition to questions for gathering demographic information (including years of experience), the questionnaire included items shown in Table 6. Data was collected for the independent variables performance expectancy, effort expectancy, social influence, facilitating conditions, self-efficacy, attitude and anxiety, and for the dependent variable behavioral intention to use CASE tools. Most constructs had three or four items in the questionnaire, with each item measured using a Likert scale. Completion of the questionnaire was voluntary.

### **Analysis**

Statistical analysis consisted of three steps. First, we averaged the associated survey items from each respondent to arrive at an aggregated score for each factor., Second, the multicollinearity of independent variables were checked by identifying correlations equal to or greater than 0.70. Finally, we ran separate regression models to test each of the hypotheses. The details of the results are provided in the results section.

## **IV. RESULTS**

Identification of multicollinearity among the independent variables can be seen in the correlation results in Table 7. We found high correlations between the following pairs of independent variables: performance expectancy and effort expectancy, performance expectancy and attitude, and effort expectancy and attitude. Correlations between these variables were  $>0.70$  with  $p$ -values  $< 0.0001$ . However, the computed variable inflation factors (VIFs) –which indicate the levels of multicollinearity with 1.00 indicating little or no multicollinearity-- ranged from 1.36 to 3.43, which are still acceptable. Hair, Anderson, Tatham, and Black [1995] suggests 10.0 as the cut-off score for acceptable VIF. To

reduce the effect of multicollinearity, we ran separate regression analyses for each of the hypotheses. The results are provided in the Table 8.

Table 7. Correlation Matrix

Variable	Perf. Expectancy	Effort Expectancy	Attitude	Social Influence	Facilitating	Self-Efficacy	Anxiety
Performance Expectancy	1.000	0.723*	0.742*	0.518*	0.285**	-0.322**	0.489*
Effort Expectancy		1.000	0.737*	0.510*	0.466*	-0.398**	0.544*
Attitude			1.000	0.598*	0.376**	-0.237***	0.542*
Social Influence				1.000	0.471*	0.050	0.596*
Facilitating					1.000	0.070	0.247***
Self-Efficacy						1.000	-0.118
Anxiety							1.000

\*p < 0.0001, \*\*p < 0.01, \*\*\*p < 0.05

We used regression analysis for testing hypotheses 1, 2 and 3. We included the moderating variables, gender and experience, along with the independent variable in the hypotheses. In hypotheses 1 and 3, gender and experience were eliminated from the model. These results show that the independent variables, performance expectancy and social influence have a significant effect on behavioral intention to use the CASE tool. However, we did not find support for hypothesis 2 – effort expectancy did not influence intention to use the system.

If we examine the results obtained from the first three hypotheses we find that the degree to which the individual believes that CASE tools will help in attaining the desired goals of the system development will have a positive impact on the use of the tool. This is a logical conclusion since students will use CASE tools more if they believe that use of the tool will help attain the goals of their project. The support for hypothesis 3 (social influence) means that the extent to which individual perceives that important others believe he or she should use the

new system has a positive effect on intention to use the system. This may be due to the fact that the project environment is a group oriented, and peer pressures can be great in this group environment. The lack of support for hypothesis 2 (effort expectancy) can be attributed to the ease of use of the CASE tool. We believe that the degree of ease associated with use of the CASE tool did not affect intention to use the system because the tool itself was intuitive and relatively easy to use. Individuals did not think that the ease of use will be a factor that will influence their use of the system.

Table 8. Results of Regression Analysis

Hypothesis	Dependent Variable	R2	F-value	Independent Variable	Coefficient
H1	Behavioral Intention	0.048	4.09*	Performance Expectancy	0.190*
H2	Behavioral Intention	N.S.	N.S.	Effort Expectancy	N.S.
H3	Behavioral Intention	0.166	16.35***	Social Influence	0.350***
H4	Behavioral Intention	0.068	6.02*	Facilitating	0.288*
H5	Behavioral Intention	0.013	1.17	Self-Efficacy	0.091
H6	Behavioral Intention	0.059	5.17*	Anxiety	0.197*
H7	Behavioral Intention	0.072	6.37*	Attitude	0.234*

\*p-value < 0.05, \*\*p < 0.01, \*\*\*p < 0.001; N.S. = Not significant

We also did not find support for hypotheses 4, 6 and 7. The independent variables facilitating conditions, anxiety, and attitude have significant effects on the behavioral intention to use a CASE tool. However, we found support for hypothesis 5 which states that computer self-efficacy has no effect on intention to use. According to our hypothesis 4, facilitating conditions, which refer to the perception that infrastructure exists to support use of CASE tools, should have no impact in the intention to use these tools. This may be a finding that is unique to the technology of CASE tools. It seems organizational and technical

infrastructure does influence use. Moreover, this result may be due to the environment in which this study was conducted. Any software that is available in a classroom environment is generally supported, since it is part of the students' learning environment. It is unlikely that students would adopt a technology for a class unless it has a high performance expectancy, effort expectancy and social influence. Two other independent variables, attitude and anxiety, were found to have a significant impact on behavioral intention to use CASE tools. This contradicts the findings of UTAUT but may be characteristic of CASE tool use. These results taken together with the lack of support for effort expectancy provides an interesting result – an individual's attitude towards using technology and the anxiety they feel towards it influence their intention to use CASE tools, but the effort expectancy or ease of use of the technology does not affect their intention to use. One may even argue that ease of use could have an effect on attitude and anxiety. Our finding that self-efficacy has no effect on intention to use CASE supported the original UTAUT.

## **V. CONCLUSION**

In this study we found support for part of the UTAUT model. Our results show that performance expectancy and social influence affect behavioral intention to use CASE tools in the classroom. This confirmed the findings of the UTAUT model. Effort expectancy did not have an effect on intention to use the case tool. This was contrary to the UTAUT model. Based on the UTAUT model we did not expect facilitating conditions, computer self-efficacy, computer anxiety and attitude toward using technology to have an effect on intention to use CASE tools. But, our results show that all these factors other than computer self-efficacy influence intention to use. This is different from the findings of the UTAUT model.

It is important for us to examine the implications of this study for information systems education. It is possible that the factors that influence information technology acceptance are very different in an organizational or

corporate environment compared to an educational setting. UTAUT research in organizations has shown that performance expectancy, effort expectancy, and social influence affect intention to use systems. In our study, which was conducted in an educational setting showed performance expectancy, social influence, facilitating conditions, anxiety and attitude influence intention to use CASE tools in systems analysis and design. The differences between the two results could be attributed to differences in the environment in which the studies were conducted (organizational versus educational) and even on the type of systems considered (functional systems versus CASE tools in our study). This has implications for the way CASE tools are taught in the classroom. Students use CASE tools if they believe that CASE tools will impact their performance in the classroom (performance expectancy). So, our courses should be designed in such a way that students believe that use of CASE tools will positively influence their performance. The ease of use of the system does not impact students' intention to use (effort expectancy). Moreover, if instructors tell students to use a CASE tool, students are inclined to use it since students believe that important others such as their instructors think that they should use the tool (social influence). Instructors should also provide adequate support for the use of CASE tools (facilitating conditions), and reduce the anxiety students feel while learning a new tool. In short, all these factors have to be taken into account while designing systems analysis and design courses that use CASE tools.

This study also has its limitations. Use of student subjects in any research raises some validity issues, and our study is no exception. But we believe that our sample could be representative of systems development teams in organizations. Around 38 per cent of our subjects had one to five years of work experience and nearly a quarter of all students had over five years experience. Moreover, a number of studies on technology acceptance have successfully used student populations [Szajna, 1996]. Another thing to note is that we investigated only the voluntary use of technology. It will be interesting to

compare determinants of technology use when use is voluntary with factors that influence use when use is mandatory.

This is a preliminary study of the use of case tools in a systems development environment. We recommend that similar research is necessary in an organizational setting to validate the findings of this study. We also found only partial support for the UTAUT model in the acceptance of CASE. This deserves further investigation. It may be important to check whether our findings are unique only to a systems development environment. We recommend that additional factors be identified that can influence user acceptance of CASE technology in systems analysis and design. We believe our research is a step in the right direction and we recommend additional studies in the field.

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