University of Alberta

EVALUATING THE IMPACT OF SOCIAL MEDIA IN 4^{TH} YEAR COMPUTER ENGINEERING COURSES

by

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Abstract

The University of Alberta ECE department offers a computer security course CMPE 420, and a capstone design course CMPE 440 for 4th year Computer Engineering students. In 2009, we deployed educational technologies to enhance the learning experience in both courses. In CMPE 420, a class blog is used to introduce a critical perspective on the security of built systems. In CMPE 440, Wikis and Tablet PCs help streamline the design and construction of the capstone projects. Our goal in this thesis is to evaluate these interventions through in-class surveys. For CMPE 420, we have developed an instrument to identify differences in experience among students and determine the blog's impact on student learning. In CMPE 440 we employ an instrument based on Technology Acceptance Theory. The results indicate that our interventions are successful with the course blog and the Wikis, but TPCs are not really successful.

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Chapter 1: Introduction

Information Technology (IT) is a rapidly-changing field, and large organizations must continually re-examine their IT systems to ensure that they still meet their users' needs and expectations. Universities and colleges, for example, deploy IT systems to improve their teaching and their students' learning outcomes. There are a variety of technologies that can be used for different educational objectives. However, the success of these interventions depends upon the students' acceptance of these technologies, and how well the particular technology matches the learning objective (i.e. *task-technology fit* [1]). These two factors evolve along with the IT field, as student's expectations of technology change (e.g. the iPad's success appears to have altered students' expectations of tablet computers). Universities and colleges spend a great deal of money on IT systems; for example, the Canadian government's Knowledge Infrastructure Program [2] designated up to $2 billion to improve facilities, equipment, and technology at Canadian schools. It is crucial that these investments be effective, meaning that each intervention be designed and assessed for task-technology fit, and periodically re-assessed [3].

Fourth-year software engineering classes are one particularly challenging context for educational technology. It is fair to say that from the first day of the class, students in these classes are already amongst the most experienced and advanced users of computer technology in the world. This is thus a highly informed and critical user population, which is unlikely to be impressed by even slightly dated technologies. For instance, we have experienced user complaints in such classes over brand-new Tablet PCs when their boot-up times were deemed excessive (replacement of Windows Vista with Windows 7 appears to have alleviated those complaints). This level of technological familiarity also complicates measuring the pedagogical effect of new technology. For instance, existing scales for measuring previous computer experience (which is expected to mediate the impact of introducing a new computer technology) can reasonably be expected to saturate at the "most experienced" level for all students, on all questions, and thus provide no useful information. The goal of this thesis is to propose and utilize measurement frameworks for evaluating three specific technological interventions in two fourth-year software engineering classes at the University of Alberta.

We will employ a survey-based evaluation strategy for evaluating our technological interventions. We will employ constructs from Social Cognitive Theory and Technology Acceptance Theory in creating conceptual measurement models for the surveys, which will then be operationalized by adapting established, previously validated survey items where appropriate. When necessary, we will develop our own survey items. Our technology evaluation will thus also include Exploratory Factor Analysis (EFA) to determine if our operationalizations are psychometrically valid, and if the relationships observed between our constructs are consistent with the established literature. We then use a correlation analysis to determine the influence of mediating variables on student outcomes. All of our surveys have been replicated in the same courses during consecutive years. In general, we have found that the measurement frameworks and operationalizations were largely (although not wholly) reliable, and two out of the three interventions were successful.

The remainder of this thesis is organized as follows. In Chapter Two we review previous work on Computer Experience, Social Cognitive Theory and Self-Efficacy, Technology Acceptance Theories, Social Media and Tablet PCs. Essential background for designing the survey is presented in Chapter Three. We detail our experimental methodology in Chapter Four, and Chapter Five provides detailed Exploratory Factor Analysis results from the surveys. In Chapter Six we explore the correlations between the factors identified in Chapter 5. We provide a general discussion and a discussion of future work in Chapter Seven. The original survey instruments are provided in the Appendices.

Chapter 2: Background Knowledge

2.1 Computer Experience

Computer experience is today usually viewed as a multi-dimensional construct, capturing a subject's interactions with a computer, their reactions to these experiences, and their learnings on the subject. However, this view arose over time, and there is an ongoing debate on what the individual dimensions of computer experience may be. Early studies, for instance, focused on the length and frequency of sessions of computer use [4, 5]. A more inclusive construct (*Objective Computer Experience* or OCE) was defined Smith et al. in [4] as the combination of all observable (i.e. external) human-computer interactions up to the present time, whether direct or indirect. The user's reactions, reflections, and other influences that contribute to computer experience were captured by the construct of *Subjective Computer Experience* (SCE), which represents a person's cognitive and affective reactions to the use of computers [4].

Jones and Clarke investigated computer experience in education, measuring computer experience using four measurement scales: "amount of computer use," "diversity of experience," "opportunity to use computers," and "sources of information" [6]. Amount of computer use is again the frequency and duration of usage sessions. Diversity examines how varied these sessions are; are multiple software packages used, and/or is the user developing their own software? Opportunity to use reflects the differing availability of computers in people's lives;

some may have access to a notebook or tablet at almost all times, others might only have access to desktops at school or work. These are all plainly external measures, and Smith et al. characterized them as direct OCE [4]. Sources of information reflect the fact that much of what is learned about computers can be second-hand information, rather than direct experience. Choosing an operating system for your home PC, for instance, does not usually involve personal testing and evaluation of all features for competing systems. Instead, the choice is often significantly influenced by reviews in the media, and the opinions of people one trusts. Smith et al. characterize this as indirect OCE [4]. Potosky and Bobko also used multiple components to measure computer experience, including frequency of use, specialized training or courses, etc. [5]. They propose a construct called "Computer Understanding and Experience," which focuses on the breadth of a user's experience and skills. They suggest that diversity of usage is a better indicator of computer experience than the frequency and duration of highly similar usages [5].

Most current investigations into computer experience also acknowledge the importance of a person's cognitive and affective reactions to computer use. Very commonly (as in TRA [7], TAM [8], etc.), cognitive reactions are treated as the user's assessment of the utility of computers and any barriers to using them, while affective reactions are captured as a person's attitudes towards computers [7]. These constructs have a long and successful history in the information technology literature (they are common elements in *technology acceptance theory*), which we review later in this chapter. Smith et al. combine cognitive and affective reactions into the construct of SCE [4]. In a different vein, Weil et al. were interested in how "computerphobia" develops; their study indicates that a person's earliest experiences with computers play a major role [9]. Generally speaking, studies tend to indicate that computer experience correlates positively with attitudes towards computers (the more experienced the user, the more positive the attitude), and correlates negatively with the construct "computer anxiety." It's important to note, however, that some studies find the opposite; greater computer experience does not always lead to more positive attitudes and lower anxiety [4].

Researchers have created numerous measurement scales to study OCE and SCE. For OCE, these include multiple choice scales, Likert-type scales, and self-defined answers. The simplest was the "yes or no" questions. For example, Arthur and Olson used nine yes/no questions for Computer Experience Scale (CES), which asked their subjects about different types of computer skills, knowledge and training [10]. Jones and Clarke used 5-point scales for each of the four aspects of computer experience, and the scores in the answers ranged from 0 ("none") to 4 ("a great deal") [6]. Bozionelos also measured computer experience using five point scales, ranging from "no experience" (scored 1) to "very experienced" (scored 5) [11]. Others used classic 5-point Likert scales questions in their questionnaires, such as [12] and [13]. For measuring SCE, researchers have used multiple-choice and Likert scales. For example, Todman and Monaghan used nine multiple choice questions to measure how "relaxed" subjects felt in their earliest computing experiences (to see if this correlated to later computer anxiety). qualitative computer experience [14]; Yaghmaie also develops an instrument for measuring SCE using 5-point Likert scales [15].

Vast numbers of studies have examined computer experience, and some studies examined experience in specific domains or related to particular tasks. Seldom research studied on the experience related to computer security, showing a gap of research for this indispensable concept come along with computer use. We believe our research for computer security experience should provide reliable and reasonable useful measurement for future computer engineering education.

The role of computer experience in education is an especially important question. For example, Ballou and Huguenard found that "Perceived Computer Experience" was correlated with performance on graded course elements [16]. Haverila determined that prior computer experience correlated with learning outcomes in a computer-mediated learning environment [17]. Chen found that higher computer experience did promote higher learning motivation, but it was not a predictor of learning outcomes. In this study, students with lower or higher computer experience performed the same [18].

2.2 Social Cognitive Theory and Self-Efficacy

Social Cognitive Theory

Social Cognitive Theory (SCT) was proposed by Albert Bandura, and is regarded as one of the most important social learning theories. SCT tries to explain how people learn new skills and behaviors in a social environment.

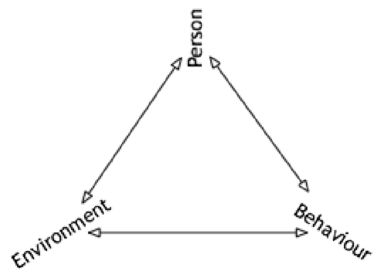


Figure 1 - Triadic Reciprocal determinants in SCT ([19] , page 24)

A famous model “Triadic Reciprocal Determinism” proposed by Bandura represented the dynamic relationships among personal cognition, behavior and environment (Figure 1). The three factors interact with each other in complex ways. For example, a person’s emotion, faith, and intention can affect his/her pattern of behavior; contrarily, behavioral outcomes can influence a person’s beliefs and emotional reactions. Similarly, the surrounding environment (physical, social, etc.) can be changed by a person’s behavior, but the conditions in the surrounding environment constrain which behaviors can be performed. For example, a student wants to select a course which he interested in (decided by personal preferences), but he can only choose from the courses provided by the university where he studies in (environment), and the university sometimes modifies the list of provided courses based on whether there is a shortage of teachers, students’ willingness to take the course (or not), or the necessity of the course (behavior) [19].

Modeling is considered a core process in SCT. Bandura indicated that people learn not only from success or failures of their own efforts, but also from observing what others do and the results they achieve. Bandura is not the first to make this observation, but his review of previous work on the topic (the processes of “imitation and “identification”) indicates that most researchers were merely interested in the duplication of behaviors, not the effect of this process on the imitator’s cognition. Two particular examples include attention-drawing and emotional arousal. Attention-drawing is the phenomena of realizing that some element of the environment can be used in a novel way (e.g. showing a child how to use a toy hammer to pound on an object for the first time helps the child realize it can be used to pound on other things too). Social learning environments also involve emotion, and modeling can stimulate emotional responses. For example, a student who never posts anything on a course blog before may itch to express his opinions and join into the online discussion when he sees a group of others discussing a topic on the blog enthusiastically. He may need to research on the resources to give valuable ideas, and he may also care about the responses from other people.

According to Bandura’s theory, in order to perform a behavior, people need to to understand how to perform the behavior and have any necessary skills(“*Behavioral Capability*”) [20]; they must believe they are able to do it (“*Self-Efficacy*”); and they must believe that the behavior will result in a desired situation (“*Outcome Expectancies*”). Bandura indicated self-efficacy was a stronger factor to predict individual’s performance than outcome expectancy in certain situations [19].

SCT plays a major role in modern theories of education. In this view, instructors can manipulate the learning environment (classroom structures, lesson delivery, etc.) to remove impediments to learning; they can teach the skills and understanding needed for certain tasks; they can help students correct negative beliefs and emotions, improving self-efficacy; provide rewards that foster positive outcome expectations; and, last but not least, serve as a model of the behaviors they wish their students to emulate [19, 21]. Researchers have consistently found that SCT's constructs are strong predictors of learning outcomes. For example, Law and Hall found that self-efficacy in learning skills and strategies was a predictor of an adult's ability to learn a new individual sport [22]. Meanwhile, Yi and Davis noted that "behavior modeling is a highly effective form of computer skill training" [23].

Self-Efficacy

Perceived self-efficacy is one of the key elements of SCT, defined as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" [19]. Self-efficacy influences people's choices to perform a behavior or to give up, and their perseverance in the face of setbacks. Self-judgments are, of course, potentially misguided; sometimes people over-estimate their abilities, while at other times we under-estimate ourselves. Despite this, self-efficacy is an important factor in learning [24, 25], and can be considered a predictor of learning outcomes in education. Moreover, self-efficacy beliefs can adapt over time towards a more realistic assessment of one's capabilities. Modeling a behavior successfully raises one's self-efficacy about that behavior, while falling short of a goal can help moderate an excessive feeling of self-efficacy [19].

Numerous studies examine self-efficacy in a variety of learning tasks, and these generally show a correlation between increased self-efficacy and improved performance of a desired behavior. Pampaka et al. studied self-efficacy in mathematics among college students across England [26]. They found the level of self-efficacy predicted the student's grade, and self-efficacy also related to students' intention to continue with mathematical study in the future [26]. Shannon et al.'s nutrition education research posited self-efficacy as a mediating variable between social factors and eating behaviors, and their results support this conceptual framework [27]. A literature review by Moos and Azevedo indicated self-efficacy was found to strongly relate to the performance of the desired behavior in a great number of studies [28].

A construct called "Computer Self-Efficacy (CSE)" has been proposed in the literature, in order to extend SCT to computer usage. Generally, this represents one's perception of their ability to use a computer (generally, or in certain situations) [29]. As with other self-efficacy beliefs, the degree of self-efficacy varies from one person to another. A taxonomy for describing this "degree" used in e.g. Compeau and Higgins breaks it down into three dimensions: magnitude (the person's assessment of how difficult a computing task they can perform), strength (how resilient their self-efficacy is to setbacks), and generalizability (how confident they are that they can perform well in new situations) [29].

Based on the review to this point, it seems that Computer Experience, Computer Anxiety, and Computer Self-Efficacy may be inter-related concepts. Researchers have investigated this contention and found that the evidence does support it [28, 30-32]. For example, Hasan examined how eight specific kinds of computer experience related to computer self-efficacy differently [33]. Based on the findings we believed the type of computer experience was a matter to the impact on self-efficacy. Doyle et al. studied a 4-year university computer science program, and showed that as computer experience increased over time, computer self-efficacy also increased, and computer anxiety decreased [31]. Karsten and Roth [34] found that training in an information systems course improved students' CSE. Importantly, they also found that students' previous computer experience had significant correlations with CSE (an unsurprising finding, but it will be significant to our own research). Orvis et al. found that the increase of task-specific experience (e.g., videogame experience in their research) and computer self-efficacy were predictors of learning outcomes [24].

Based on how self-efficacy can affects learning outcomes, factors which may affect computer self-efficacy were studied in several researches. Bandura proposed four mechanisms by which self-efficacy beliefs are modified: *mastery experiences* (the subject performs a behavior, moving from simple examples to more complex situations, gaining confidence in their abilities along the way);

vicarious experiences (the subject observes a peer performing the behavior, again moving from simple to more complex instances; the subject's own self-efficacy is improved when they believe that they can emulate this behavior); *social persuasion* (peers or educators give genuine positive reinforcements – as opposed to uncritical praise – that help alleviate self-doubts); and helping the subject achieve a relaxed *physiological state* (subjects feeling stress or fatigue may associate those sensations with the behavior, and interpret them as signs they aren't capable of the behavior) [35]. Dinther et al.'s review indicates that actual performance of a behavior, verbal encouragements, and modeling were also seen as strongly influencing self-efficacy beliefs in classroom settings. Unsurprisingly, interventions designed using social cognitive theory as their foundation were more effective in improving student self-efficacy that interventions based on other conceptual frameworks [25].

Self-efficacy is usually investigated via surveys measuring the subjects' perceived ability to perform particular tasks. Self-efficacy beliefs are dependent on the task at hand, and are typically treated as multidimensional quantities [36]. There is thus no single "self-efficacy survey;" rather, researchers must develop instruments tailored to the particular task under investigation. For example, Compeau and Higgins investigated computer self-efficacy. They used yes/no questions (with a confidence score of 1-10 for each "yes" response) for ten computer self-efficacy questions in the survey [29]. Leutzinger and Newman developed a questionnaire to evaluate a program that teaches participants to deal with minor wounds an illnesses at home [20][20]. Their measurement model was designed partially based on SCT, with 15 items to measure the magnitude and strength of self-efficacy using 5-point Likert scales [20]. Compeau et al. [37] measured self-efficacy using the 10-item scale from [29], and compared this to the "Computer Attitude Scale" [38] and "the Computer Anxiety Rating Scale" [39]. Pre-post test models are commonly used to trace the change of self-efficacy in different situations. For example, Martocchio and Judge created pre-post measurements with 7-point Likert scales assessing subjects' self-efficacy in using a specific software package [40]. Karsten and Roth also used a pre-post test model with 5-point Likert scale items to test computer self-efficacy in their questionnaire [34]. Karsten and Schmidt reviewed divided computer experience into the categories "Task-specific measures of Computer Self-Efficacy (TCSE)" and "General Computer Self-Efficacy (GCSE)" [41]. They recommended that computer self-efficacy related to specific tasks should be divided from self-efficacy in the general use of computers, with both being important factors in a study [42]. Yi and Davis also supported distinguishing TCSE from GCSE when measuring self-efficacy [23]. Hasan asserts that scales for TCSE should be developed or adjusted to fit the particular task at hand. When this was done, TCSE was more powerful than GCSE in predicting two factors (Perceived Usefulness and Behavior Intention) in the Technology Acceptance Model (reviewed later in this chapter) [43]. Based on these arguments, computer security self-efficacy in our research is an instance of TCSE, because we wish to measure capability in the computer security domain, rather than the general use of computers.

2.3 Technology Acceptance Theories

One of the key questions in introducing a new learning technology is whether students will accept it; do they find the technology helpful, or is it a waste of their time? Technology acceptance theories seem to be useful in guiding empirical studies to answer this question. Li provided a literature review of well-known theories and models which had been developed in this domain [44], including the Theory of Reasoned Action [7], the Technology Acceptance Model [8] and the extended TAM (TAM2) [45], Theory of Planned Behavior [46], the combined TAM and TPB [47], the Unified Theory of Acceptance and Use of Technology (UTAUT) [48], and Social Cognitive Theory [19].

Theory of Reasoned Action (TRA)

Theory of Reasoned Action (TRA) was proposed and developed by Fishbein and Ajzento account for how people decide to perform or not perform a given behavior. They specified three important components in the model: *Attitude* captures positive or negative feelings about a behavior, *Subjective Norms* capture the subject's perception of others' opinion of a behavior, and *Behavioral Intention* captures how strongly the subject intends to perform the behavior in question. TRA assumes that behavioral intentions are the direct antecedent of performing the behavior, and many studies invoking TRA or its relatives use this assumption to make Behavioral Intention to response variable in the study (as actual behaviors are often harder to measure; Behavorial Intention, on the other hand, is captured via survey items, just like the other factors in TRA) [7]. As we can see from Figure 2, different beliefs influence attitude and subjective norms, which in turn influence the person's intention to perform the behavior.

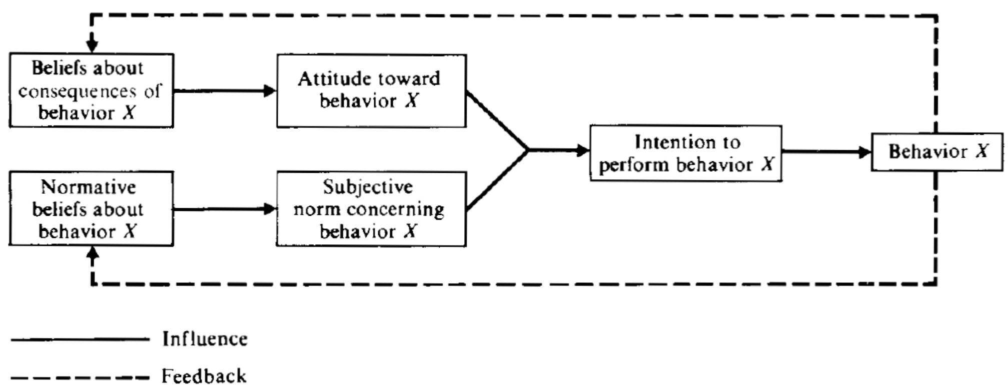


Figure 2 - Theory of Reasoned Action (TRA) [7], p.16

TRA is, of course, a fairly limited model, and is properly applied only to certain situations, ideally those in which an individual is free to make rational choices without other constraints [49], [44]. Specifically, TRA should be restricted to situations meeting three conditions: (1) The choice to perform the behavior is consciously made by the subject, and is not hampered by their own abilities or outside influences; (2) behavioral intentions are stable; (3) behavioral intentions and actual behaviors are consistent [49, 50]. Despite these limitations, TRA is a foundation for several other models in technology acceptance theory.

Theory of Planned Behavior (TPB)

Ajzen extended TRA to the Theory of Planned Behavior (TPB) by adding a major component "Perceived Behavior Control (PBC)" which reflect individual beliefs about future difficulties to perform a behavior based on prior experience [46]. Similar to TRA, TPB assumes that beliefs influence attitudes and subjective norms, which then influence behavioral intentions (see Figure 3). However, TBP relaxes the assumption of full control over one's behaviors, acknowledging that external circumstances can constrain an individual's choices [46]. If people perceived that all required resources for the behavior are available, they will likely assume fewer difficulties exist when performing the behavior [51].

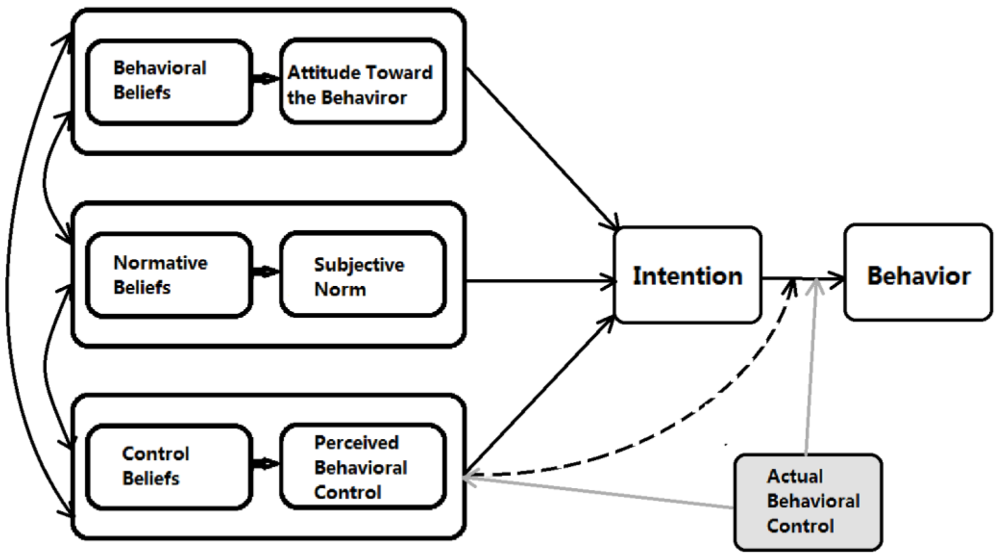


Figure 3 - The Theory of Planned Behavior [52]

Technology Acceptance Model (TAM) and TAM2

The Technology Acceptance Model (TAM) is one of the best-known and most widely-used models in technology acceptance theory. TAM is based on TRA, specializing the general theory to the specific case of choosing whether or not to use technological innovation [8]. Two important beliefs "Perceived Usefulness" (USEF) and "Perceived Ease of Use" (EOU) in TAM are assumed to influence individual's Attitude, which in turn influences the use of the technology (see

Figure 4). Both Perceived Usefulness and Perceived Ease of Use refer to the degree of an individual's beliefs; Perceived Usefulness focuses on the belief that using the technology will improve performance on a given task, while Perceived Ease of Use is the belief that using the technology will not require much effort. In the original TAM instrument developed by Davis in 1987, 7-point semantic differential scales were used to measure Attitude, and 7-point Likert scales were used to measure USEF and EOU [8]. In an empirical study, Perceived Usefulness was found to significantly influence both Attitude and Actual System Use. Perceived Ease of Use had a much weaker relationship with Attitude and had no direct relationship with Actual System Use, but influenced Usefulness significantly, in turn to affect the Attitude and Actual Use indirectly. Attitude appeared to have only a weak influence on actual system use [8].

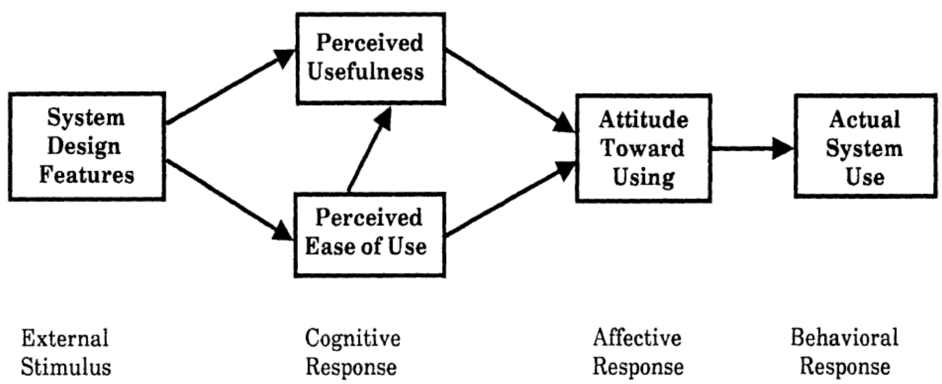


Figure 4 - Technology Acceptance Model (TAM) by Davis [8]

As a specialization of TRA, TAM has certain limitations. However, it seems a reliable measurement tool and has been frequently used in many researches. Thus, it has also been used extensively to study educational technology acceptance (that is, whether students and instructors choose to use a new technology. For example, Rezaei et al. [53] and Park [54] analyzed student's intention to use e-Learning; Ngai et al. [55] added a factor "Technical Support" to determine usefulness and ease of use in TAM and examined how university students accept to use WebCT; Elwood et al. [56] investigated students' acceptance of university-issued laptops; Park et al. [57] and Teo [58] tested instructors' intention to adopt a technology or electronic courseware in their classes. One important development to note is that the factor Attitude in TAM has often been dropped in research models. Davis' 1987 work did not show a strong relationship between Attitude and system use, and in subsequent research he dropped the factor from his model. Much of the field (although not all of it) followed suit. Currently, this is considered an open question [59].

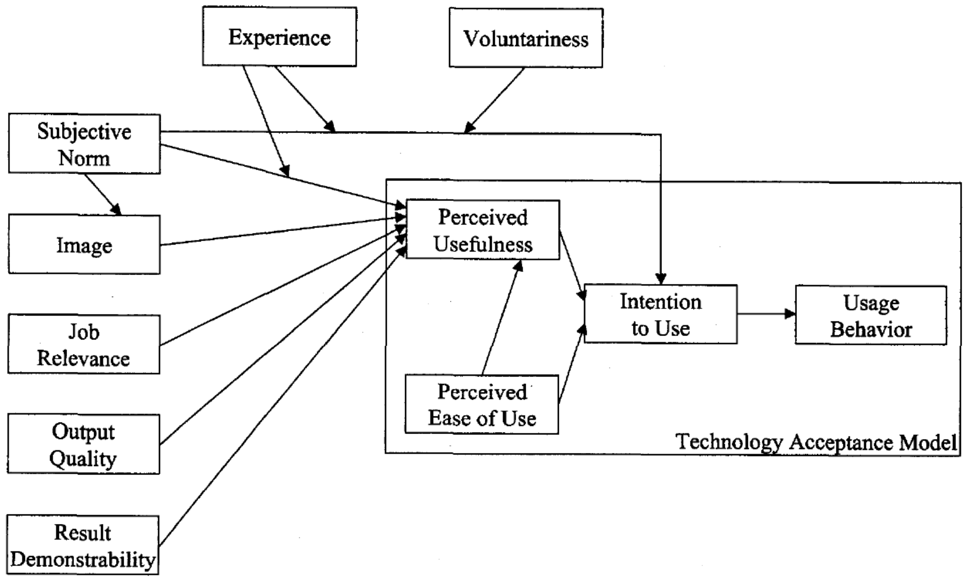


Figure 5 - TAM2 by Venkatesh and Davis [45]

As with TRA, TAM's major limitations is the small number of factors used to explain a technology adoption decision. Many authors have pointed out that other factors have a bearing on this choice, and have therefore extended the TAM model to include them, e.g. [60] and [61]. One of the well known models is TAM2 (see Figure 5). Venkatesh and Davis wanted to capture how well the results of using a technology (good or bad) match with task objectives; they claimed that this is an important element of perceived usefulness. They also found that Intention to use a technology can be affected by Subjective Norms directly and significantly when using the technology is mandated by higher authority (but not when using the technology is a voluntary choice) [45]. The C-TAM-TPB model was developed by Taylor and Todd [47]. They combined TPB with TAM together, emphasizing the importance of prior experience [47].

Decomposed TPB is a more complex model combining TAM and TPB [62]. It decomposed the three factors representing beliefs in TPB, thus improving the explanatory power of the model.

Naturally, TAM and TRA are not the only theoretical foundations for technology acceptance research. Motivation Theory, for example, relates enjoyment and perceived usefulness to usage intentions [63]. Motivation can be categorized as extrinsic (the behavior leads to rewards other than the activity itself, such as improved grades or bonus) or intrinsic (the behavior is performed for its own sake, not external rewards). Perceived usefulness can be considered as an extrinsic motivation, and enjoyment is a type of intrinsic motivation. Research showed that usefulness has a stronger effect on intention than enjoyment, but both of them were significant [63].

The Diffusion of Innovation is a theory to study how and why innovations are adopted in a social setting, and what factors affect this process. Its basic principle is that a new innovation penetrates into its target audience following "S-curve," with an initial low adoption rate (limited to early adopters) giving way to a rapid expansion (as the mainstream takes it up), and reaching a plateau as its target audience becomes saturated [64]. Rogers identified five perceived properities ("relative advantage, compatibility, complexity, trialability and observability") that tend to be common among most successful innovations [64]. Moore and Benbasat studied Information Technology innovation acceptance in their research, focusing on potential user perceptions of accepting the technology, and extended Roger’s five properties with a few more factors, including “Voluntariness,” “Image,” “Ease of Use,” “Result Demonstrability,” and “Visibility” [65]. The Model of PC Utilization (MPCU) was developed by Thompson et al. [66], based on Triandis’ theory (which says that intention is influenced by the subject’s attitudes and emotional response to the behavior, social norms, and anticipated results of the behavior. In turn, behavior is influenced by intention, the subject’s own habits, and context [67].) Thompson et al. specialized Triandis’ theory for predicting Personal Computer utilization. They hypothesized six factors would affect the Utilization of PCs directly. Results indicated that the utilization of PCs was significantly influenced by “Job Fit,” “Complexity” of using PCs, “Long-term Consequences” and “Social Factors” [66].

Unified Theory of Acceptance and Use of Technology (UTAUT) is a model integrating factors from the models and theories above, including TRA, TPB/DTPB, TAM/TAM2, Combined-TAM-TPB, Motivation Theory, Theory of Innovation Diffusion, and SCT [68]. Venkatesh et al. included four factor influencing intention and usage in UTAUT: *Performance Expectancy* (perceived utility of the technology in improving task performance); *Effort Expectancy* (ease of use of the technology); *Social Influence* (identical to Social Norms in TRA) and *Facilitating Conditions* (perceived support (or lack thereof) for using the system in the individual’s social and technological environment). Empirical results showed that UTAUT explained a high level of variance for the Intention to Use construct, and is thus a useful model.

2.4 Social Media Technology

“Social media” is a common term today, used to refer to everything from blogging to Facebook. However, an investigation of its use in the classroom requires a more precise definition. Doing so is rather difficult, as much of the literature conflates “Web 2.0” and “social media” together. One proposed definition deems “social media” to be the application of Web 2.0 technologies to facilitate the publication of user-generated content [69]. These technologies include rich-media platforms (e.g. Flash, Silverlight, elements of HTML 5); syndication platforms (e.g. RSS); blogs; and Web application frameworks (e.g. Ajax, Rails, other elements of HTML 5) [70]. Another key characteristic is that social media enable a many-to-many communication pattern, rather than the one-to-many communication of traditional broadcast media and earlier Web technologies. This facilitates the creation and organization of on-line communities, the social units of Web 2.0 [71]. Others view user-generated content, online collaboration, and social networking as signature features of Web 2.0 [72]. Still others regard the technologies as secondary. Web 2.0, in their view, is an ideology shared by the creators of the various technologies, which emphasizes collaborative development and sharing of user-generated content [73].

User-Generated Content (UGC) refers to media content created and published by “individual users,” prototypically individuals not connected with a “mainstream” media outlet. IN a report, the OECD identifies three distinguishing characteristics of UGC: The work must be a *creative effort* (a new or derivative work with substantial original elements), it must be *published* (disseminated to some target audience), and it is *not created in a professional capacity* [74]. For example, a blog may be written by a journalist for his newspaper; most would not describe this as user-generated content because this is part of his professional responsibilities, for which he is paid. A personal blog, written by the same journalist on his own time and for his own interests, would be UGC.

Kaplan and Haenlein categorize different forms of social media using four characteristics: *social presence* (the type and degree contact that can be achieved) and *media richness* (the total combination of explicitly and implicitly communicated information that can be sent in a unit of time using a medium) are argued to form one aspect of this categorization. The other aspect is the degree of *self-presentation* (the degree of control a user has over how they are perceived by others) possible, and the degree of self-disclosure (revealing personal details either deliberately or inadvertently) that occurs. Social media vary widely in these aspects; wikis were found to have low self presentation/disclosure and low presence/richness, while virtual worlds involved extensive self-presentation/disclosure, and provide high social presence and media richness [69].

Plainly the various definitions above converge on the importance of individual users expressing themselves and cooperatively sharing their ideas with a larger group; beyond that, it is difficult to pin down an exact technical definition for "social media." Understood in this general sense, the appeal of social media for educators is unsurprising. It offers the opportunity to engage students to a degree that the traditional lecture model does not, by allowing the students to create some of the class content themselves, share it with their classmates and instructor, and receive feedback from all of them. Results from a recent survey shows that more than 80% of university and college faculty incorporated social media into their instruction to some degree. More than half of them used different kinds of social media in class, such as wikis, blogs and online videos; 30% communicated with students through social networks [75]. More and more universities and colleges are adopting Web 2.0 teaching tools [76], even as researchers continue to elucidate the strengths [77, 78], and pitfalls [79, 80] of web 2.0 tools in an educational setting. Minocha's review [71] indicates that the collaborative nature of social media is also a key characteristic for educators, and is a welcome change from the isolated, often competitive environments fostered by traditional classroom approaches. Social media were particularly useful in distance education, allowing students who were not co-located to still enjoy the benefits of a learning community (i.e. a *community of practice*). Motivational factors for using social media, benefits to educators and students, and social media use cases were all discussed. As with any technology, the benefits of social media must be weighed against the risk inherent in its use. The key risks identified in [71] were resistance to new technology (closely related to technology acceptance and computer anxiety, as discussed before), access problems (whether there is inequality of access to the technology within the class), difficulties in integrating technology into lesson plans, and technological problems (the usual IT questions of customization, deployment, maintenance, security, privacy protection, etc.). To mitigate these risks, some universities have published guidelines for how faculty should employ social media in their classes, and researchers generally agree that a social media deployment must be carefully designed to integrate with the learning activities and outcomes in a class [71] [69]. Blogs, for instance, promote journaling and reflection, while Wikis are useful supports for group projects.

Blogs

First named “weblogs” by Jorn Barger in 1997 and shortened to “blog” by Peter Merholz in 1999 [81], blogs today are a hugely popular social medium. An earlier study indicated that in 2004, 12,000 blogs were being created daily [82], increasing to roughly 100,000 per day by October 2006 [83]. More than 1.2 million posts were published every day, and about 3.9 million people updated their blogs every week in Q1 2006 [84]. Kaplan and Haenlein describes blogs as websites hosting UGC that is generated serially over time, with “entries” time stamped and displayed in reverse chronological order. There is a wide variation in blog formats, and the topics of a blog are wholly at the writer’s discretion [69]. In educational use, blogs are employed for a number of purposes, includingorganizing students’ studies (e.g. knowledge logs and learning journals), journaling, keeping in touch with other people, assessing student learning, and managing tasks [81]. Each entry of the blog can be a mix of text, hyperlinked text, images, videos, and so on [69, 85]. The most common blog configuration involves one owner who writes (and can edit) the blog entries, and readers who can add comments. Usually when blog is used for personal or general purpose, its entries can be published by the blog owner, and possible to be commented by other viewers [69]. Group blogs (e.g. a course blog) are a less common configuration where all of the group members can contribute entries and comments. Setting up, maintaining, and posting to a blog requires little effort or technical skill; however, group blogs often work best when an experienced facilitator helps lead the discussions [85].

In higher education course blogs can be used for providing course materials from the class, and recording, discussing, and reflecting on what has been learned, [85]. Blogs appear well-suited for reflective writing [86], knowledge construction [85, 87, 88], and building communities of practice [89, 90]. They appear to effectively support discovery-based learning and forming connections (key processes in constructivist and connectionist learning theories, respectively) [91]. Student self-reports also indicate that course blogs improved learning. However, this finding should be interpreted cautiously. The same study found a negative correlation between giving and receiving feedback on the blog, and the level of reflection apparent in the student's work. A content analysis indicated that feedback tended to be shallow social expressions ("I agree," "good job," etc.) rather than substantive commentary [81]. Cultural factors can also influence the success of a course blog. For example, in some Asian societies the "loss of face" that could accompany criticism might be a serious harm to the person criticized; the social dynamics of a class might thus be severely upset by introducing a course blog [85].

The concepts of a "community of practice" was introduced by Lave and Wenger in [92], and have seen extensive use for *knowledge management* (institutionalizing knowledge artifacts so that they survive the departure of their creators) in large orgnizations [93] and cooperative learning in education. The social aspects of a community of practice are critical; all members need to feel that their contributions are valued, that they can grow and express themselves freely, and that there is a shared interest in the growth and success of the community [89]. Wenger et al. indicated that a community of practice needs its members to fill certain group roles if the community is going to prosper (e.g. someone needs to coordinate social events, there needs to be a "core group" of highly motivated members to drive the community's day-to-day interactions, etc.) [94]. As blogs are tools for recording and sharing knowledge, a blog (or a collection of blogs) can be employed as the technological basis for a community of practice, as pointed out in [90].

Wiki

A wiki is a website whose contents and structure are both UGC, usually developed by multiple users. Wikis maintain a repository of all previous versions of each page (allowing regression to any previous version), and frequently include tools for commenting on and discussing page contents, as well as monitoring tools. A wiki is one common choice of computer-supported collaborative work tools [95]. A good example is Wikipedia, which is an online encyclopedia managed and updated by many users world-wide [95]. In a corporate setting, about 20% of

Nokia's staff uses wikis to access and share project information and ideas internally [69].Tonkin listed and described different types of wikis, including "single-user wikis", "lab books", "collaborative writing" wikis, and "knowledge base" wikis [96].

Similar to blogs, wikis are generally studied as a tool for communication, knowledge construction [97], collaborative learning, writing and project work [95, 97, 98], reflective learning [95, 99], forming communities of practice [95], and other specific tasks including distributing course materials and giving presentations [100]. Researchers often specifically identify wikis with the constructivist learning paradigm, which holds that learning is the result of an interaction between the learner and their environment (this tends to be the philosophical basis for discovery-based and active learning in the literature). In particular, *social* constructivism holds that this interaction necessarily involves a social group. Interactions with others in the social group (peers, parents, teachers, etc.) and reflective thinking are primary means by which experiences are translated into new knowledge. One thing to notice for this research is that Wiki becomes popular in project-based learning [95]. Wikis support several important tasks which somewhat tangential to the education purpose of the project: recording group and personal daily activities, creating, tracking and modifying project plans, archiving requirements and test cases for long term use, and version control [95].

There has been particular interest in using wikis in design project courses. For example, in Chen et al.'s research they discussed how students use wikis and weblogs and the "Folio Thinking" method to support reflective thinking in an engineering design course [99]. Minocha et al. studied use of wikis for collaborative learning in software engineering courses, and particularly the use of wikis for requirements gathering [101]. Meishar-Tal and Gorsky studied activities students like or do not like to perform using wiki in collaborative writing, and indicated students did not like to delete existing content in a page, but like to append new text to it most of the time [97]. Ras and Rech examined how can wiki help students to gather knowledge in capstone projects. Wikis were used to create "learning spaces;" by one measure, this technique doubled the effectiveness of learning [102]. Overall speaking, Wiki is considered as an efficient tool for learning, which should be well suited in project courses in software engineering education.

Some of the particular challenges in using wikis in higher education also revolve around the wiki's main capabilities. Some wikis do not enforce access restrictions, and so the content of a group's page could be altered by outsiders (or even disaffected group members). This is famously the case for Wikipedia, but can also be a problem on other wiki platforms [69]. Another problem is sometimes students do not like to change or comment on content authored by other people, and also dislike the idea of others modifying their writing [97]. Instructors using wikis need to set ground rules and expectations to cover these situations.

2.5 Tablet PC in Higher Education

Prior to 2010, a Tablet PC (TPC) was a mobile device larger than a cell phone, but smaller than a full-size laptop computer, with a pen-based input option the enabled handwriting and free hand drawing on their touch-sensitive screens. Software support for "digital inking" (adding a bitmap of the pen's trajectory across the screen to a document) was also a signature capability [103, 104]. These pen based computers came in different form factors: convertible TPCs, slate PCs, and hybrid TPCs [105]. Slate PCs are touchscreen-only devices, with the default input device being the pen. The most common design was the convertible Tablet PCs; these have full QWERTY keyboards, and usually look like normal laptops, but their screens are jointed to the keyboards by swivel hinges which supports 180 degree rotations. Once its screen is rotated and secured over the keyboard, the convertible TPC will look like a slate [3, 105]. In the hybrid design, the keyboard is detachable.

In 2010 Apple introduced their slate-like product iPad, which has utterly upended the TPC market. Previously, TPCs were a niche market with limited sales. The sales reports from Apple show that more than 32 million iPads (including the iPad and iPad 2) were sold worldwide during their fiscal 2011 (September 25th, 2010 to September 24th, 2011 [106-109]. The iPad differs from other slates in that it uses a capacitive touchscreen, which responds to the close proximity of a human finger (rather than a stylus). iPads are variations of slate PCs, but a number of experts (including both Bill Gates and Steve Jobs) argue that they are not true "Tablet PCs," since they do not run any version of a desktop operating system [110]. The lack of a physical keyboard means that iPads are not well-suited to handling voluminous text input, thus in real-time classes, taking e-notes efficiently will become a problem. Other similar products such as HP touchpad, LG G-Slate, Samsung Galaxy Tab, Motorola Xoom and RIM PlayBook have similar operating styles based on fingertip gestures, and similar limitations.

TPCs have drawn the attention of the educational community for several reasons. First, the TPC allows handwritten notes to be stored and accessed electronically, and eliminates the need for separate notebooks in different classes [111]. TPC software usually includes the ability to cut & paste multimedia content, facilitating the presentation and dissemination of course [112]. TPC software (e.g. DyKnow) permits interaction between instructor and student TPCs, enabling real-time exercises and feedback online [103]. Reports from classes in several disciplines (e.g. mathematics, engineering, physics and chemistry) indicated that learning outcomes were improved by using the TPC [113], [114]. Multiple sources have observed that the keyboard is not an effective note-taking device for classes with a large amounts of graphics in the notes; TPCs have been singled out as move effective in those cases [115], [111], [116]. Pilot programs at select universities have shown that equipping students with TPCs enhanced learning outcomes [117]. TPCs do seem to be more effective in classes with a large problem-solving component, and particularly design-oriented courses [118], [119]. Some studies do indicate that task-technology fit is particularly crucial for TPCS, observing that significant improvements in learning outcomes only appear when the fit is “strong” [116, 120], [119]. Most research into TPCs in education focuses on a single course. For example, Kurtz et al.’s research examines a software engineering course [121]. Koile and Singer evaluated the “Classroom Learning Partner” software in an introductory computer science class [122].

Adoption of TPCs by students seems to be variable. Hieb and Ralston found that, despite widespread student agreement that presenting lecture materials using a TPC is a significant improvement over traditional means, many students would not be interested in using TPCs in their own note-taking [112]. Moran et al. applied the UTAUT model to explain student’s acceptance of the TPC. Key recommendations for improving acceptance include: better communication of the expected benefits of the TPC to the students; improved training; and improved support (in particular, a public helpdesk) [123]. Similarly, El-Gayar and Moran showed that TAM could also model student acceptance of TPCs [124]. Cromack identifies seven principles for incorporating Tablet PCs into undergraduate education [125].

It seems TPCs are useful in higher education, but there are still some limitations. For example, there might be some technological problems (e.g., hand writing recognition accuracy, system stability [126], [103]). Users often need training for the new software applications on a TPC [103, 127], and price may be a consideration. Ergonomics are also a potential problem, as TPCs allow for notetaking in very poor postures [3]. An interesting perspective from Caroline and

Jamie is electronic notes and recorded lectures may lower the students' class participation and their grades [113].

Chapter 3: Survey

There are four major objectives for the surveys reported in this chapter: (1) to validate a new Computer Experience scale for 4th year software engineers, (2) to determine the impact of a course blog in enhancing computer security education, (3) to determine the impact of Wiki on a capstone design course, and (4) to determine the impact of the distribution of Tablet PCs on a capstone design course.

3.1 Educational Context

3.1.1 CMPE 420 Reliable and Secure Systems Design

The CMPE 420 Reliable & Secure Systems Design is a lecture-oriented computer engineering course offered at the University of Alberta. It teaches students basic knowledge computer security vulnerabilities and controls, and how to achieve reliability for software systems. It employs a course blog as a class component, which is intended to create a learning environment which can effectively develop and promote students' "security mindset" and critical thinking skills. Students in this course are fourth-year computer engineering students (the course is required for software option students only).

The major topics covered in the course are drawn from two fields, software reliability engineering and computer security. As these are quite different topics, each one is organized as a six-week module. The software reliability module emphasizes a variety of design and programming techniques to achieve software reliability, focusing on fault tolerance mechanisms. In the computer security module, students are introduced to different kinds of threats to the security of software and computer systems, and corresponding controls and strategies against them. Furthermore, instructor also discusses non-software threats and controls in the physical environment where computer systems exist.

In Fall 2008, a course blog was introduced to provide students an online environment as a "community of practice," following the model created by Dr. Tadayoshi Kohno in his course CSE 484 in University of Washington. A major objective of the course blog is to teach students the "security mindset," which is a special viewpoint that a professional software engineer should have. In essence, it is a particular form of critical thinking about the security of systems a software engineer builds. Rather than just considering how a system can be built to fulfill a need, the software engineer must also consider how their system could be subverted, either by accident or maliciously. This viewpoint is very different from what the students have previously been exposed to, and it needs to be practiced before the students are comfortable with it and able to incorporate the "security mindset" into their own work. It was decided that a community of practice is the best mechanism for developing this mindset, and a course blog was selected as the implementation strategy.

Every student is required to post a thoughtful entry, posting or comment every week as a contribution to the course blog. The topics can be arbitrary, but they should reflect higher-order critical thinking (analysis, evaluation, and synthesis in Bloom's taxonomy [128], should generally be related to computer security. At the beginning of the semester, the instructor usually acts as a facilitator and initiator of the community. We have noticed that as the semester went on, students were willing to take up the initiator role from the instructor, especially those students with more computer experience. Students provided positive feedback about the course blog, which has encouraged us to undertake a formal evaluation of the blog. This was done in CMPE 420 in Fall 2009 and Fall 2010.

Students in CMPE 420 may have different backgrounds and experience with computer and software engineering, but most of them have little experience in the domain of computer security. The prerequisite of CMPE 420 is a course called "Introduction to Software Engineering" (CMPE 300), and both of them are required for all computer engineering students in all degree streams. Software Option students also take a number of other courses in Software Engineering and Computer Science. However, students in the other computer engineering degree streams (Traditional and Nanoscale System Design) will not. This is likely the first time that 4^{th} year students have had a course in computer security, thus we consider them novice learners in this domain. As discussed by Kirschner et al., some researchers argue that novice learners need "direct instructional guidance," with procedures, concepts and learning strategies explicitly explained; pure discovery-based learning (in which these are learned empirically) is considered less effective for novices [129].

3.1.2 CMPE 440 Software Systems Design Project

CMPE 440 Software Systems Design Project is a required capstone course for students in the software option of the Computer Engineering program at the University of Alberta. Students are asked to design relative complex and reliable software systems in a collaborative learning environment. We provide the students with a wiki and issue a TPC to each student for the duration of the semester to support them in this work. These two technological innovations were added to the CMPE 440 beginning in 2008; we therefore wish to understand student acceptance of them and their effectiveness in supporting the students' learning outcomes.

CMPE 440 asks students to employ integrate previously learned knowledge from the software engineering stream courses. These include courses from classical computer engineering, software engineering, and computing science. Most students take CMPE 440 in their final year or final semester of undergraduate studies, so we believe these students should have all required skills and knowledge to build large-scale software systems. It's reasonable to consider them as "advanced learners," who should be able to effectively follow a discovery-based learning curriculum. The team projects are the main work for the semester, but there are also several laboratory assignments that introduce students to a mobile-computing infrastructure we have provided. There is one lecture a week, which supports these labs; students are expected to plan and execute their team projects independently, with weekly reports to the instructor.

The main objective of CMPE 440 is to require students to experience the development of complex software systems in groups under realistic constraints, in order to integrate and apply what they have learned in their undergraduate studies. The projects are either provided by local companies, or suggested by the instructor or by students. Teams must develop a software requirements specification and submit it for the instructor's review. On acceptance, they will then design, construct and test the system, and must deliver a working prototype at a final presentation at the end of the semester. Students also need to deal with constraints similar to situations in the industry, such as managing time and deadline pressure, team dynamics and communication, and so on.

Students are supported by instructor and the university in several ways. A Wiki was introduced as an electronic design workbook; project-related resources such as the requirements specification and user interface prototypes will be posted on it. A set of convertible TPCs were received as a donation from Hewlett-Packard Technology for Teaching (TfT) Grant in 2008, and used as development tools for the mobile computing laboratories. They can also be used as development and/or target environments for the term project, note-taking platforms in this and other courses, and in general as a personal computing device. We chose the convertible TPC because software engineering design requires a mixture of voluminous text (which is best entered using a keyboard), and diagrams that are best drawn with a stylus. Slates (either the older stylus-based ones, or the iPad and its competitors) are less effective platforms for this combination of tasks. Students may also use their own laptops (and several do), but we want to provide equal and stable opportunities for everyone in the class. In order to evaluate the utility of Wiki and Tablet PCs, we deployed survey instruments at the end of the Winter 2009 and Winter 2010 semesters.

3.2 Survey Design

In general, surveys are a popular method in information technology research. In this field, they are used to measure non-observable phenomena of importance (people's opinions, reactions, and states of mind are good examples). Empirical research on technology acceptance, for instance, is almost always based on survey instruments. A good survey should have a set of relevant questions for different constructs (postulated factors that influence an outcome). Each question should relate to one and only one construct [130], be unambiguous and concise and use either a positive or negative wording (but not both) [131]. In developing a new set of questions for a construct (known as a *scale*), one attempts to capture the various aspects of the construct (this process is called operationalization). The survey designer attempts to ensure validity (the question measures what it purports to measure) in each question (survey *item*). This scale must then be administered to a population (the first study is usually considered a pilot, and is given to a much smaller population than the completed survey is targeted at). The results are then analyzed, checking both validity and reliability using statistical measures questions with low validities and reliabilities should be re-designed or removed from the survey [131]. In our research, we reuse existing, validated scales to maximum extent possible; for example some factors were taken from

Greene et al.'s model for high school students' cognitive engagement and achievement [132] and Davis's TAM model [8]. These questions were modified to fit our educational context, and then analyzed for validity and reliability (all of our surveys are best considered pilot studies, as the populations are small and some of the items in the surveys have not previously empirically validated). Questions for other factors were designed by us, such as Computer Security Experience and Security Self-Efficacy in CMPE 420, and Use of Wiki and Tablet PCs in CMPE 440.

3.2.1 CMPE 420 Survey Conceptual Framework

The goal of the course blog in CMPE 420 is to help change student's abilities in, and thinking about, computer security; thus, it seems clear that multiple measures are needed. The CMPE 420 surveys follow a pre-post survey model, which consists of an initial survey and a final survey. There are 14 questions in the initial survey and 34 questions in the final survey. The initial survey was taken in class a few weeks into the semester, before the computer security module began. The final survey was taken in the last day of the class before the final exam of the semester, which means students had completed the computer security module. In order to distinguish students' responses from each other on the initial and final survey, an ID code was randomly assigned to each student. The outcome we sought to measure was the construct "Security Self-Efficacy." We define this construct as students' perceived ability to identify and correct security vulnerabilities in the world around them. This is an operationalization of the concept of the “security mindset,” relying on self-reports. While such a design is vulnerable to over- or under-estimates on the student’s part, we believe this is a reasonable interpretation of the degree to which the students adopt the “security mindset,” as it reflects the students’ confidence in applying a new style of cognition. Similar to other self-efficacy studies, changes in self-efficacy over the course are measured using a pretest-posttest design.

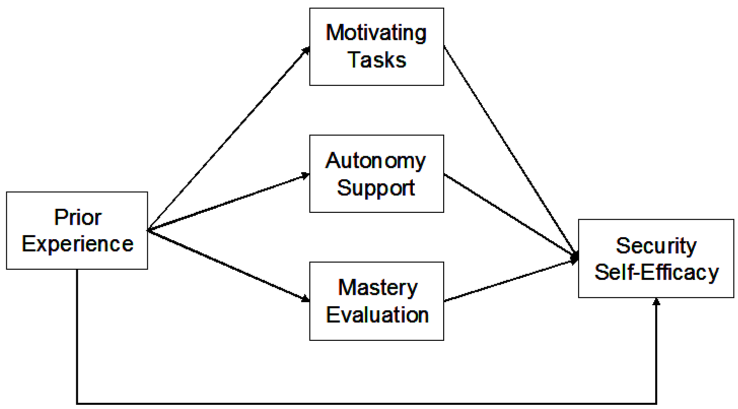


Figure 6 - Path Model for CMPE 420 Surveys

Following the existing literatures, our conceptual framework (see Figure 6) assumes that Security Self-Efficacy is influenced by its precursors, including Motivating Tasks, Autonomy Support, Mastery Evaluation [132] and Prior Experience in computer security; Prior Experience also can influence the other three factors [4]. The initial survey measures Prior Experience and Security Self-Efficacy before the course, while the final survey measures Motivating Tasks, Autonomy Support, Mastery Evaluation, and the Security Self-Efficacy after students take the course.

Prior research indicates that computer experience is a predictor of student learning outcomes [16], especially for courses that focus heavily on computer usage [133]. Anecdotally, we have noticed that students have different levels of familiarly with topics in computer security, possibly due to different work experiences and hobby interests. These experienced students usually ask questions on key points or initiate discussions during the class. They contribute to healthy patterns of classroom communication, and are valuable resources to help students with less experience. Thus, prior computer experience is important to both students and teachers, and evaluating the levels of students' computer experience is important to computer engineering education in our department. From our literature review, we noticed most of measurements are designed for general computer use or for particular software systems, and most of the subjects are from the general public. There are no scales measuring experiences specific to computer security. Furthermore, our subjects are fourth-year computer engineering students at a major university, meaning they should be considered as among the most experienced and knowledgeable computer users in the population. It's likely that every one of them will give a "most experienced" response on every question if we administer the existing computer experience scales. Thus, if we want to measure different levels of computer security experience for our students, we need to design new scales which are sensitive enough to recognize differences among these highly-trained individuals. As prior experience is obviously part of a student's background knowledge on arriving in CMPE 420, these questions should be asked as a part of the initial survey.

Questions 1 to 5 in the initial survey (in following tables we will use I1 to I5 to represent these questions) are designed for the *Computer Security Experience* factor (see Appendix 1: CMPE 420 Initial Survey). They ask about security related tasks that an advanced computer user may have performed at work, at school or at home. For example, an advanced user may have opportunities to maintain and operate computer systems, set up computer networks, install and configure router-based firewalls, administer web and email servers, create and maintain websites, and develop software applications. In addition, students who have industry work experiences may already have received security training from their employer. These trainings could be specific to security in information technology; they may include security in the physical environment, such as cash drawer handling, access restrictions, working-along principles, and store open and close procedures. All of these experiences can assist students for learning in CMPE 420. We condense these tasks and situations into five questions, including the largest computer network administration experience, the most complex website design experience, the most complex software system design experience, the length of computer-security training, and the length of other types of security training. We believe these five items should cover students' experiences which are useful to CMPE 420. Provided answers for these questions are multiple choices with five possible responses. These answers are designed to show a logarithmic increase of time or complexity, as this tends to be a more "natural" representation for human cognition than linear scales [134].

The factor *Security Self-Efficacy* is represented by questions 6 to 14 in the initial survey (items I6 to I14) and questions 26 to 34 in the final survey (items F26 to F34). CMPE 420 aims to improve students' security awareness concerning network and computer systems; however, security is by nature a holistic concern, encompassing IT systems, the physical environment they exist in, and the people accessing them. Thus, the course incorporates considerations of the physical and social issues surrounding computer security, not just the technical ones, and we expect to see a corresponding increase in student self-efficacy in all of these domains. To operationalize "security self-efficacy," we consider the three stated objectives of the blog: identifying security weaknesses, proposing controls to counter them, and evaluating those controls. We ask the students how confident they are in each of these tasks for three environments: IT systems, their own physical/social environment, and for new technologies (see Appendix 1: CMPE 420 Initial Survey). We repeat these same questions on the final survey (see Appendix 2: CMPE 420 Final Survey). Responses for these questions are seven-point Likert scales anchored from "Strongly Disagree" (a score of 1) to "Strongly Agree" (a score of 7).

Question 1 to question 25 in CMPE 420 final survey (item F1 to F25) are items for three factors shown to positively influence self-efficacy in the classroom, namely Motivating tasks, Autonomy support, and Mastery evaluation (see Appendix 2: CMPE 420 Final Survey). The three factors were adopted from Barbara's model relating perceptions of class structures to achievement [132]. We adjusted for the existing items for these factors to fit the context of our course.

Items F1 to F9 measure the factor *Motivating Tasks*, which captures the extent to which students find the blogging assignments and blog posts relevant to what they are learning, sensible, and interesting. Items F10 to F14 capture *Autonomy Support*, which reflects whether or not students believe they have the freedom to manage their own learning; this includes encouraging conscientiousness and self-regulation. Items F15 to F25 cover *Mastery Evaluation*, which refers to students' perception of whether they are graded on an absolute scale, or in competition with other students. These items again employ 7-point Likert scales anchored on "Strongly Disagree" and "Strongly Agree" with equal intervals (score of 1 to 7).

3.2.2 CMPE 440 Survey Conceptual Framework

The CMPE 440 survey (see Appendix 3: CMPE 440 Survey) was designed to investigate acceptance of wikis and Tablet PCs in the course. As such, the most appropriate design appears to be a single survey given at the end of the course. It was designed based on the Technology Acceptance Model (TAM) [8] and hypothesized that attitude towards using the wiki/TPC, perceived usefulness of the wiki/TPC, and perceived ease of use of the wiki/TPC will influence the use of the wiki/TPC. In TAM, Attitude is measured by 7-point semantic differential scales, and both Usefulness and Ease of Use are measured by 7-point Likert scales [8]. Questions for these three factors have been repeatedly shown to be valid and reliable. We therefore adapted these existing scales to our context. The construct of "Use" is different from the other factors. The actual use of a technology is often difficult to measure; a common approach is to instead measure "Intention to

Use" (based on the TRA theory that intentions are the antecedent of actual use). As we found no validated scales measuring the actual use of a wiki, we created two "intention to use" items. In measuring use of the Tablet PC, we located existing measurement scales for laptop usage, which seemed to map well onto the expected use of the Tablet PCs [135, 136]. We therefore adapted these scales for our context.

Items 1 and 2 in the survey measure attitude towards using the wiki and the Tablet PC, respectively. The "*Attitude toward using*" defined by Davis refers to "the degree of evaluative affect that an individual associates with using the target system in his or her job" [8]. Items 3 to 10 cover Perceived Usefulness (USEF) of the wiki, and items 11 to 18 cover the perceived usefulness of the Tablet PCs. *Perceived Usefulness* refers to how strongly a student believes that using Wiki or TPC is helpful for his study or work, and will enhance his learning or job performance. Items 19 to 28 cover Perceived Ease of Use of the wiki, and items 29 to 38 cover Perceived Ease of Use for the Tablet PC. Items 19, 21, 23, 25 and 27 are negative-wording questions. These are aimed at ensuring that when students answer the survey, they do read, understand and respond to the questions, instead of circling answers without thinking. Items 20, 22, 24, 26 and 28 are positive wording questions. Items for Tablet PCs follow the same pattern of positive and negative wording questions. Items 48 and 49 are the "intent to use" questions for the wiki; these ask if the student intends to use a wiki for software design projects in the future, and will he/she use it in the next year. The answers are also measured by seven-point Likert Scales Items 39 to 47 obtain a self-reported measurement of "actual use of Tablet PCs." We aimed to know the frequencies of using a Tablet PC for different tasks, such as checking emails, doing homework, and looking for resources on the internet. These multiple-choice questions use five-point logarithmic scales as their responses. We also want to know if the students are willing to pay a premium for the Tablet PC over a standard laptop, and so provide seven choices to measure the dollar amounts. We use a linear scale for this item because it seems unreasonable that answers would vary by more than a single order of magnitude, especially since the total price of a Tablet PC is under $1000.

Chapter 4: Materials and Methods

The objectives of the research are (a) to validate the questions in the CMPE420 initial survey for the computer experience, (b) to validate the questions in the CMPE420 final survey, (c) to compare the CMPE 420 initial and final survey, and (d) to validate the questions in the CMPE440 social media survey for the factors ATT, USEF, EOU and USE.

4.1 Data Sources

The CMPE 420 survey follows a pre-post testing model, as discussed in Chapter 3. The survey took place in the Fall term of 2009 and was repeated in Fall 2010. Data from each semester was analyzed when it was received, but the class was relatively small, and thus the data size was small in each semester. There were 18 responses for the initial surveys in Fall 2009, and 13 responses for the final surveys. Then it decreased to 9 responses for initial survey and 9 for final survey in Fall 2010. Thus, an additional analysis pooling the results from both administrations was pursued. CMPE 440 is a capstone project course. As discussed in Chapter 3, the survey was a single end-of-term questionnaire, administered at the end of the Winter term in 2009 and 2010. There were 11 responses collected in Winter 2009 and 9 responses collected in Winter 2010. Again, these were analyzed separately, and were also pooled to reduce small-sample effects.

The two courses were offered in the university in two consecutive years and taught by the same instructor, and data sizes were relative small. We decided not to count several conditions into the model, such as the difference of teaching environments, student's gender, age, and so on. These factors were fairly homogeneous for the two cohorts, so their effects should be minimal. More importantly, due to the small population sizes, including these factors would introduce a substantial re-identification risk, which we were not prepared to accept. As the cohorts were fairly homogeneous, we adopted the pooling method from [137], [138], and [139], which is to simply append the surveys together without further adjustments.

4.2 Methodology

4.2.1 Exploratory Factor Analysis

Researchers usually use Exploratory Factor Analysis (EFA) to explore the underlying common factors among a set of items and measure the strength of relationships between the factors and items [140]. We want to use EFA to validate the items in our surveys, investigate their underlying factors and confirm the construct of factors for TAM model. We will use the SPSS software package to perform our EFA. Per Henson and Roberts, a researcher must make the following decisions to perform a EFA analysis: (a) choose the matrix type to use, such as covariance or correlation (b) decide which extraction method he wants to use, such as Principal Components Analysis or Principal Axis Factoring), (c) decide on a stopping rule for factor extraction, and (d) choose a rotation method (orthogonal or oblique) improve the interpretability of the extracted factors [141]. Pett. et al. [131] and Thompson [142] emphasized sample size is also important.

PCA refers to principal component models which aims to explore item interrelationships by calculating linear combinations of original items generate a set of independent “principal” components. The components of items are calculated based on inter-item covariance or correlation , and all initial item communalities (h^2) are equal to 1 [131]. The other methods provided by SPSS in factor analysis refer to Common Factor Analysis (CFA). Pett et al. indicated (p. 89),

> Variance in a given item [was] explained by a small number of underlying factors plus variation that [was] unique to the item, including error variance. The factors that we extract in CFA [were] not just mere linear combinations of the items being examined, as in PCA, but [were] instead hypothetical factors that [were] estimated from the items being examined. [131]

Therefore in CFA less than 100% of item variances are extracted, and initial communality of items are less than 1 [131].

Choosing an appropriate factor analysis method from several different extraction methods can be difficult. Costello and Osborne found some researchers believed principal components method had little difference from factor analysis, or even preferred it to factor analysis [143]. Thompson mentioned the difference between PCA and PAF was not obvious when the item reliabilities were high [142]. On the other hand, a lot of researchers argue that PCA is not a factor analysis method. Per Costello and Osborne, “principal components analysis does not discriminate between shared and unique variance. When the factors are uncorrelated and communalities are moderate it can produce inflated values of variance accounted for by the components” [143]. [144] recommended maximum likelihood as the best choice to deal with normally distributed data, because “it allows for the computation of a wide range of indexes of the goodness of fit of the model [and] permits statistical significance testing of factor loadings and correlations among factors and the computation of confidence intervals” [143, 144]. In this research the small data size makes some variables not normally distributed, so we cannot consider maximum likelihood as the first choice. Fabrigar et al. indicated Principal Axis Factors (PAF) was a better choice if multivariate normality cannot be achieved (cited by Costello and Osborne) [143]. Pett et al. suggested using PCA for a pilot test to gain understanding from the data, and then compare PAF with those results [131]. Based on these recommendations, we applied both PCA and PAF, and compared their results in the experiment.

In order to make structure in the data simple and clear, extracted components are often rotated, aligning coordinate axes with the observed factors. There are two categories of rotations, which are orthogonal and oblique. Orthogonal rotations do not consider the relationships among factors, while oblique rotations do [131]. Varimax and oblimin are two commonly used rotation methods in SPSS, and a lot of researchers use varimax as their orthogonal rotation method. There are also different methods for oblique rotations, but it seems their results are similar to each other [143]. We tried both varimax and oblimin rotation methods in our EFA using SPSS. The results for both are virtually identical, thus only the result from varimax will be presented in this thesis.

Sample size is an important concern in empirical research, and it is the essential problem in our work. Thompson provided recommendations about the minimum sample size from several researchers, such as "10 to 20 per measured variable," "no less than 100 individuals for any analysis," 100 to 200 if h^2 is around 0.5, and so on; one author even found as few as 60 subjects can provide an accurate result [142]. Due to the enrollments in the two courses in this research, none of these rules of thumb can be satisfied, even when we pool the data from two years. Costello and Osborne suggested when data structure was "strong", in another word, all item communalities are high (>0.8) and only load strongly in one factor, then a smaller data size may acceptable [143]. Rather than rely on these rules of thumb, we use several statistical tests to explicitly determine whether the data we have collected is adequate for EFA.

4.2.2 EFA Procedures

The correlation matrix is used to check the pattern of relationships between variables. Pett et al. recommended researchers to look for modest correlation scores between 0.3 to 0.8, and items with out-of-range corelation scores should be dropped from the group [131]. Moreover, the determinant of the correlation matrix should be greater than 0.00001 [145]. Per Pett et al., when the determinant is 0, scores of some columns or rows in the matrix are linear combinations of other columns or rows, which makes the matrix singular [131]. This could happen in many situations, such as one response of the measurement is identical to another (which happened in our data), the item correlation scores are extremely high, or when the diversity of data is not strong enough to distinguish the properties of different items (e.g. data size is too small) [131] . We use the Kaiser-Meyer-Olkin (KMO) test and Bartlett's Test of Sphericity to evaluate the correlation matrix and to see if a factor analysis is appropriate or not. KMO compares the observed correlations to the observed partial correlations; high scores of this statistic indicate that there is a significant relationship betweent the different factors, making a factor analysis appropriate [131]. The higher a KMO value is, the better the result is. For example, above 0.8 is great, 0.5 to 0.7 is moderate, but under 0.5 is unacceptable [146]. Bartlett's test examines whether the "correlation matrix is an identity matrix" as the null hypothesis in a chi-squared test, which would mean the data does not form a correlation matrix of factorable items [131]. In sum, a factor analysis will be meaningless whenever KMO value is too small (<0.5) of or Bartlett's test is insignificant [131].

Communality (h^2) refers to the total of squared factor loadings, which explains how much of the item's variance can be explained by all the latent components or factors. Researchers will expect to see a high value of communality, but if an item communality is low, either it should be eliminated from the group, or new components or factors are needed [131].

A Scree Plot shows the eigenvalues associated with each principal component in a descending order. Usually only the extracted components or factors with a steep slope in the plot will be extracted as factors. While this is a visual examination and not properly a "test" the scree test does have a long history of producing useful results [131].

4.2.3 Reliability Analysis

Data from surveys can be dichotomous, ordinal, or interval data, but it should be coded numerically. By observing the Means and Standard Deviations of data for each item, we can get a rough idea about how the data looks like and which items can be grouped together. The most important result in reliability analysis is Cronbach's alpha, which measures how consistent are the items, in order to indicate whether the group of items represent a single construct [147]. Cronbach's alpha is given by [147]:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}} \qquad (1)$$

In the formula $\bar{c}$ refers to the average item covariance, $\bar{v}$ is the average of item variance, and N is the number of items [147]. The value of α should be at least greater than 0.5; a score greater than 0.7 is preferred [148].

4.2.4 Shapiro-Wilk Test and Marginal Homogeneity Test

In order to evaluate the changes of security self-efficacy before and after students take CMPE 420, we use the Shapiro-Wilk Test for item normality and the Marginal Homogeneity Test to examine the significance of differences between paired items in pre-post surveys.

The Shapiro-Wilk Test was selected to examine item normality. We have tried Q-Q plots at the beginning, but it was difficult to tell the shape of the distribution in a graph when the data size was small, thus we selected Shapiro-Wilk Test instead. This test is preferred to the Kolmogorov-Smirnov test when the data size is small (i.e. less than 50) [149], and so it is more appropriate for our research. The null hypothesis in the Shapiro-Wilk test is that the data come from a normal (Gaussian) distribution. We found that not all pairwise differences were normally distributed in 2009, 2010 or after pooling. This was an important consideration when we selected the test for comparison of paired items.Marginal Homogeneity Test is the method used to compare related samples in our research. Unlike the paired T-test, the Marginal Homogeneity Test does not require normality in the data; as discussed previously, we have already found that normality was violated [150, 151].

Chapter 5: Exploratory Factor Analysis Results

This chapter represents the detailed results from the exploratory factor analysis. Section 5.1 states the results of the EFA in the CMPE 420 survey model; section 5.2 analysis the results of the EFA in the two TAM models of CMPE 440; and section 5.3 summarizes and discusses the principal findings in the analyses.

5.1 Results for CMPE 420 Surveys

5.1.1 Computer Experience

The goal of this analysis is to validate new computer experience scales for 4^{th} year software engineers. Based on the analysis we find out the pooled data is reliable for factor analysis (but not reliable in 2010), and it suggests a two-factor solution based on the five computer experience items. One factor focuses on the largest network which a student has been responsible for designing and developing. The other factor covers the items for the largest websites and software systems a student has been responsible for designing and developing. The two factors overlap on the items which ask about security training experiences.

There are 26 valid responses used in the reliability test. In Table 1 Cronbach's Alpha scores indicate that data in 2010 (α=0.609) has a lower internal consistency than in 2009 (α=0.808); after pooling, the data has a moderate internal consistency (α=0.732). The means are lower than or equal to 2, which is about the second level of the scales. This indicates students on average very limited have computer security training and experience before they take the course. A lower mean score on I4[1] means students have less other kinds of training experience than computer security trainings. From the item standard deviations we can say that our students have similar experience on working with networks, but they have a wider variety of computer security training experiences and experience in building software systems.

Table 1 - Computer Experience Reliability

	Item Statistics						Reliability		
	Mean			Std. Deviation			Cronbach's Alpha		
	09	**10**	**09-10**	**09**	**10**	**09-10**	**09**	**10**	**09-10**
I1	1.94	2.00	1.96	0.43	0.71	0.53	0.808	0.609	0.732
I2	2.00	1.78	1.92	1.50	1.30	1.41			
I3	2.12	1.56	1.92	0.93	1.13	1.02	**Case valid**		
I4	1.65	1.33	1.54	1.06	0.50	0.90	**09**	**10**	**09-10**
I5	1.71	2.56	2.00	1.21	1.51	1.36	17/18	9/9	26/27
Scale Statistics	9.41	9.22	9.35	4.078	3.42	3.794			

In the correlation matrix (see Table 2) the inter-item correlations are positive and range from weak to intermediate in 2009. In 2010 I1 has negative correlations with I3 and I5. Pooled data items have low correlations with each other, which range from -0.155 to 0.629. Overall speaking the matrix indicates that computer experience items have weak to intermediate correlations with each other, especially for item I1 (largest responsible networks).

[1] I4 means the 4th question in the initial survey. In the thesis I use "I" short for "initial."

Table 2 - Computer Experience Correlation Matrix

Correlation Matrix					
2009					
	I1	**I2**	**I3**	**I4**	**I5**
I1	1.000				
I2	0.194	1.000			
I3	0.176	0.764	1.000		
I4	0.227	0.591	0.555	1.000	
I5	0.445	0.481	0.755	0.450	1.000
2010					
	I1	**I2**	**I3**	**I4**	**I5**
I1	1.000				
I2	0.543	1.000			
I3	-0.469	0.179	1.000		
I4	0.707	0.896	0.074	1.000	
I5	-0.351	0.452	0.529	0.221	1.000
09-10					
	I1	**I2**	**I3**	**I4**	**I5**
I1	1.000				
I2	0.318	1.000			
I3	-0.155	0.553	1.000		
I4	0.296	0.629	0.438	1.000	
I5	0.056	0.418	0.522	0.293	1.000

The item communalities (see Table 4) for the pooled data indicate PCA I4 and I5 have lower explained variances than other items, and in PAF I1, I4 and I5 share small parts of their variance in common with the others. KMOs from the pooled data or individual years (see Table 5) indicate that the partial correlations among items are weak, and item sampling adequacy is just acceptable for factor analysis. Bartlett's Test of Sphericity is significant (χ^2=35.82, p=.000), supporting the use of EFA on this data. Both PCA and PAF indicate that two factors should be extracted. Factor one comprises of item I2, I3, I4 and I5, while factor two comprises of I1, I2, and I4. Questions about security training (I2 and I4) have heavy cross-loadings on both factors. We can tentatively label the two extracted factors as “Websites & Software Systems” and “Networks.”

Table 3 - Computer Experience Factor Analysis

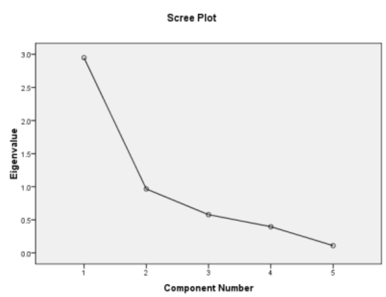
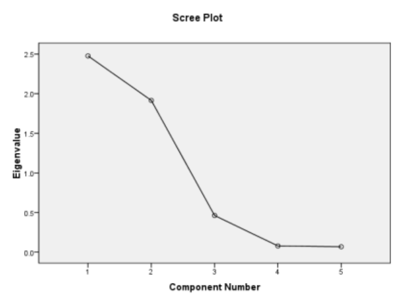
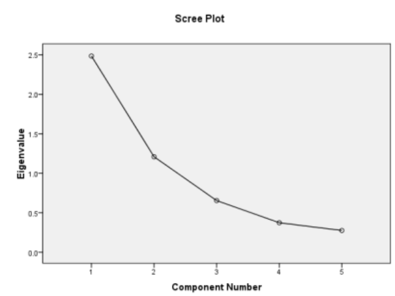
Factor Analysis	**2009**	**2010**	**09-10**
Correlation	Determinant = .072	Determinant = .012	Determinant = .204
KMO	.615	.559	.648
Bartlett's Test of Sphericity	Approx.Chi-Square= 35.441, df=10, sig.=.000	Approx.Chi-Square=24.504, df=10, sig.=.006	Approx.Chi-Square= 35.820, df=10, sig.=.000
Extration sums of Sqared Loadings(PCA)	One Component, Cumulative =58.954%	Two Components, Cumulative = 49.487, 87.835%	Two Components, Cumulative= 44.621, 73.892 %
Extration sums of Sqared Loadings(PAF)	One factor, Cumulative =51.291%	Two factors, Cumulative= 48.093, 80.252%	Two factors, Cumulative= 38.856, 59.453%
Scree Plot			

Table 4 - Computer Experience Communalities

	Communalities (PCA) *			Communalities (PAF)					
	2009	2010	09-10	2009		2010		09-10	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
I1	0.195	0.951	0.859	0.305	0.106	0.867	0.987	0.297	0.411
I2	0.689	0.952	0.777	0.663	0.599	0.882	0.946	0.562	0.753
I3	0.811	0.741	0.822	0.808	0.863	0.555	0.488	0.533	0.998
I4	0.565	0.949	0.677	0.391	0.419	0.888	0.913	0.434	0.515
I5	0.687	0.799	0.560	0.705	0.578	0.713	0.678	0.302	0.295

* Initial in PCA are 1s.

Table 5 - Component (Factor) Matrix of Computer Experience

	Component Matrix (PCA)					Factor Matrix (PAF)				
	2009	2010		09-10		2009	2010		09-10	
	C1	C1	C2	C1	C2	F1	F1	F2	F1	F2
I1	0.441	0.744	-0.630	-0.135	0.917	0.325	0.769	-0.629	-0.061	0.638
I2	0.830	0.950	0.224	0.704	0.531	0.774	0.928	0.292	0.650	0.574
I3	0.901	0.023	0.861	0.901	-0.101	0.929	-0.009	0.698	0.989	-0.142
I4	0.752	0.974	0.008	0.588	0.575	0.648	0.954	0.061	0.504	0.510
I5	0.829	0.268	0.853	0.748	0.017	0.760	0.205	0.797	0.533	0.109

Rotation Method: Varimax with Kaiser Normalization.

5.1.2 Change in Security Self-Efficacy

To measure how students' security self-efficacy changes after they take CMPE 420, the first necessary step in this analysis is to confirm that there is a significant difference between the initial and final responses. Security self-efficacy is measured by nine identical items in both initial and final surveys. Analysis indicates that students show a significant improvement of security self-efficacy. We therefore create nine items which reflect the arithmetic subtraction between each pair of initial and final items. The data is reliable for factor analysis, and it suggests a three-factor solution for these nine items. The detailed analysis is presented in the following.

We have 22 valid pairs of responses in total which have good reliabilities (see Table 6). The other 4 cases have no final response, so they cannot be used in the comparison of pretest-posttest items. From the means and std. deviations of I6 to I8 in initial survey we can see that students have low level of confidence to analysis security problems, suggest methods to control them, or to decide the best way to improve them in a computer system. This may because students who going to take a computer security course are likely unfamiliar with computer security. The means of I9 to I11 indicate that students have some level of confidence when they face security problems in their physical or social environment. They may already know how to avoid security problems and keep themselves safe in these environments. The means from I12 to I14 show that students are less confident about security problems with new technologies.

Table 6 - Reliability for Initial and Final Items

	Item Statistics					
	Mean			Std. Deviation		
	09	10	09-10	09	10	09-10
I6	3.85	2.89	3.46	1.14	1.27	1.26
I7	3.92	3.78	3.86	1.19	1.48	1.28
I8	3.46	3.44	3.46	1.20	1.33	1.22
I9	4.85	5.67	5.18	0.80	0.71	0.85
I10	5.00	5.56	5.23	0.71	0.88	0.81
I11	4.92	5.44	5.14	0.76	0.73	0.77
I12	3.85	4.78	4.23	1.21	1.20	1.27
I13	3.85	4.11	3.96	1.07	1.05	1.05
I14	3.46	3.67	3.55	1.20	1.12	1.14
F26	5.23	4.22	4.82	0.60	1.48	1.14
F27	5.39	5.22	5.32	0.65	1.20	0.89
F28	5.00	5.00	5.00	1.00	1.23	1.07
F29	5.39	6.00	5.64	0.77	1.12	0.95
F30	5.54	6.00	5.73	0.66	1.00	0.83
F31	5.08	6.00	5.46	0.76	1.00	0.96
F32	5.00	5.00	5.00	1.00	1.32	1.11
F33	5.00	5.11	5.05	0.71	0.93	0.79
F34	4.77	4.89	4.82	1.17	0.78	1.01
Scale Stat.	83.54	86.78	84.86	7.50	11.05	9.02

Reliability		
Cronbach's Alpha		
09	**10**	**09-10**
0.755	0.861	0.807
Case valid		
09	**10**	**09-10**
13/17	9/9	22/26

From the raw data we determined that in some cases the final response were lower than the initial responses. This is reasonable because students may overestimate their abilities when they lack computer security knowledge. After students learn more, they should have a better understanding about the abilities they have, and may adjust their perceived self-efficacy appropriately. This could lead to a decrease from an initial response to a final response. The differences between initial and final item averages range from 0.15 to 1.55. Items I9 vs. F29, I10 vs. F30, and I11 vs. F31 from the pooled data increase less than 0.5, which means students feel their confidence about analyzing, evaluating and synthesizing security problems in physical or social environment has a smaller change than with computer and new technologies. Overall speaking, the means of all items increase from initial to final surveys (see Table 6).

Table 7 - Test of Normality for Initial & Final Items

Initial Items (Sig.)	**2009**	**2010**	**09-10**	**Final Items (Sig.)**	**2009**	**2010**	**09-10**
I6	.027	.094	.017	**F26**	.003	.095	.000
I7	.003	.046	.001	**F27**	.003	.586	.007
I8	.031	.407	.025	**F28**	.143	.830	.056
I9	.012	.024	.006	**F29**	.035	.065	.008
I10	.012	.338	.007	**F30**	.002	.081	.007
I11	.014	.008	.001	**F31**	.014	.081	.017
I12	.008	.076	.024	**F32**	.143	.396	.111
I13	.037	.039	.001	**F33**	.012	.012	.001
I14	.031	.102	.003	**F34**	.045	.055	.008

To check for significant differences between initial and final items, the first step is to test their normality to see which comparison method is appropriate. Table 7 shows the significance of normality for each item in a Shapiro-Wilk test. The null hypothesis of normality is rejected for most of these items, and so Marginal Homogeneity Test is more preferred in the research to test the significance of the differences between initial and final items.

The results from Marginal Homogeneity Test (see Table 8, Table 9, and Table 10) indicate there are significant differences between most of the initial and final items, particularly when the two surveys are pooled. The score of item 11&31 (sig.=0.097) indicates that students don't feel their confidence on deciding the best way of improving security in physical or social environment improve significantly. Except 11&31, all of other items from the pooled survey have clear positive changes in different aspects of security self-efficacy, which means our teaching goals have been achieved, and students' security mindsets have been improved successfully. We will now proceed to compute the derived items for "change in security self-efficacy" by taking subtracting each individual's initial response from their final response on the security self-efficacy items. We will then perform an EFA of these derived factors.

Table 8 - Marginal Homogeneity Test for Initial & Final Items in 2009

	6 & 26	7 & 27	8 & 28	9 & 29	10 & 30	11 & 31	12 & 32	13 & 33	14 & 34
Distinct Values	6	4	7	5	4	4	6	5	6
Off-Diagonal Cases	9	10	10	9	7	5	9	8	9
Observed MH Statistic	31	36	31	43	33	24	31	27	29
Mean MH Statistic	40	45	41	46	36.5	25	38.5	34.5	37.5
Std. Deviation of MH Statistic	3.317	3.202	3.606	2.062	1.803	1.414	3.428	2.872	3.202
Std. MH Statistic	-2.714	-2.967	-2.774	-1.698	-1.941	-.707	-2.188	-2.611	-2.655
Asymp. Sig. (2-tailed)	.007	.003	.006	.090	.052	.480	.029	.009	.008
Exact Sig. (2-tailed)	.004	.002	.002	.145	.094	.750	.023	.008	.004
Exact Sig. (1-tailed)	.002	.001	.001	.072	.047	.375	.012	.004	.002
Point Probability	.002	.001	.001	.055	.039	.219	.010	.004	.002

Table 9 - Marginal Homogeneity Test for Initial & Final Items in 2010

	6 & 26	7 & 27	8 & 28	9 & 29	10 & 30	11 & 31	12 & 32	13 & 33	14 & 34
Distinct Values	5	7	7	4	4	4	5	5	5
Off-Diagonal Cases	7	5	7	7	6	7	7	7	7
Observed MH Statistic	18	17	24	38	31	37	34	28	25
Mean MH Statistic	24	23.5	31	39.5	33	39.50	35	32.5	30.5
Std. Deviation of MH Statistic	3.317	3.571	3.082	1.803	1.732	1.803	2.000	2.693	2.291
Std. MH Statistic	-1.809	-1.820	-2.271	-.832	-1.155	-1.387	-.500	-1.671	-2.400
Asymp. Sig. (2-tailed)	.070	.069	.023	.405	.248	.166	.617	.095	.016
Exact Sig. (2-tailed)	.094	.062	.016	.594	.406	.281	.812	.141	.016
Exact Sig. (1-tailed)	.047	.031	.008	.297	.203	.141	.406	.070	.008
Point Probability	.023	.031	.008	.156	.125	.094	.172	.039	.008

Table 10 - Marginal Homogeneity Test for Initial & Final Items in 09 -10

	6 & 26	7 & 27	8 & 28	9 & 29	10 & 30	11 & 31	12 & 32	13 & 33	14 & 34
Distinct Values	6	7	7	5	4	5	6	5	6
Off-Diagonal Cases	16	15	17	16	13	12	16	15	16
Observed MH Statistic	49	53	55	81	64	61	65	55	54
Mean MH Statistic	64	69	72	86	69.5	64.5	73.5	67	68
Std. Deviation of MH Statistic	4.690	4.796	4.743	2.739	2.500	2.291	3.969	3.937	3.937
Std. MH Statistic	-3.198	-3.336	-3.584	-1.826	-2.200	-1.528	-2.142	-3.048	-3.556
Asymp. Sig. (2-tailed)	.001	.001	.000	.068	.028	.127	.032	.002	.000
Exact Sig. (2-tailed)	.001	.000	.000	.099	.042	.194	.036	.002	.000
Exact Sig. (1-tailed)	.000	.000	.000	.049	.021	.097	.018	.001	.000
Point Probability	.000	.000	.000	.030	.015	.058	.010	.001	.000

Items based on pooled data are reliable (α=0.878) (see Table 11). Correlations between the items are from 0.134 to 0.853 (see Table 12), and most of them correlated with each other intermediately (around 0.4 to 0.6).

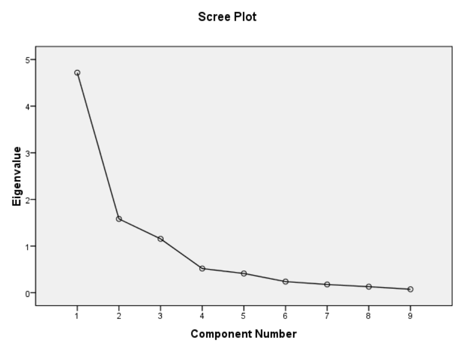
Table 11 - Change in Self-Efficacy Reliability Test

	Item Statistics		Reliability
	Mean 09-10	Std. Deviation 09-10	Cronbach's Alpha 09-10
I6_F26	1.364	1.497	0.878
I7_F27	1.455	1.471	
I8_F28	1.545	1.335	**Case valid**
I9_F29	0.455	1.101	**09-10**
I10_F30	0.500	0.964	22/22
I11_F31	0.318	0.945	
I12_F32	0.773	1.541	
I13_F33	1.091	1.306	
I14_F34	1.273	1.120	
Scale Statistics	8.773	8.141	

Table 12 - Change in Self-Efficacy Correlation Matrix

Correlation Matrix 2009-2010									
	I6_F26	**I7_F27**	**I8_F28**	**I9_F29**	**I10_F30**	**I11_F31**	**I12_F32**	**I13_F33**	**I14_F34**
I6_F26	1.000								
I7_F27	0.635	1.000							
I8_F28	0.563	0.619	1.000						
I9_F29	0.473	0.219	0.277	1.000					
I10_F30	0.462	0.134	0.222	0.853	1.000				
I11_F31	0.486	0.473	0.233	0.678	0.653	1.000			
I12_F32	0.409	0.048	0.295	0.513	0.369	0.150	1.000		
I13_F33	0.737	0.572	0.544	0.367	0.341	0.400	0.531	1.000	
I14_F34	0.591	0.557	0.532	0.435	0.309	0.364	0.727	0.731	1.000

Table 13 - Change in Self-Efficacy Factor Analysis

Factor Analysis	**09-10**
Correlation	Determinant = .001
KMO	.737
Bartlett's Test of Sphericity	Approx.Chi-Square= 123.952, df=36, sig.=.000
Extration sums of Sqared Loadings(PCA)	Cumulative= 32.957, 61.227, 82.82 %
Component(PCA)	Three components
Extration sums of Sqared Loadings(PAF)	Cumulative= 31.2, 57.358, 76.617%
Factors(PAF)	Three factors
Scree Plot	

The results (see Table 13) indicate items have moderate data adequacy (KMO=0.737), and the correlation matrix is not an identity matrix (χ^2=123.952, p=.000), which means reasonable for factor analysis. A three-factor solution is suggested (Table 15). Factor one includes three items about computer systems (I6_F26, I7_F27 and I8_F28) and two items about new technologies (I13_F33 and I14_F34); factor two perfectly loads on items about the physical or social environment (I9_F29, I10_F30, and I11_F31); and factor three loads on items about new technologies (I12_F32, I13_F33 and I14_F34). Factor one and two have overlaps on two items (I13_F33 and I14_F34). A possible reason is that students may not separate computers from new technologies. Computers might be important components of a new technology, especially in the field of information technology. It's reasonable to affect both when students' security mindset improves. The communities of items indicate the variances of items are accounted from moderate to relative high by the three factors (Table 14).

Table 14 - Change in Self-Efficacy Communalities

	Communalities (PCA) 09-10	Communalities (PAF) 09-10	
	Extraction	Initial	Extraction
I6_F26	0.744	0.690	0.676
I7_F27	0.891	0.785	0.887
I8_F28	0.640	0.503	0.473
I9_F29	0.901	0.825	0.888
I10_F30	0.882	0.783	0.837
I11_F31	0.828	0.668	0.652
I12_F32	0.950	0.806	0.995
I13_F33	0.774	0.697	0.703
I14_F34	0.845	0.821	0.784

Initial in PCA are 1s.

Table 15 - Change in Self-Efficacy Factors

	Component Matrix (PCA) 09-10			Factor Matrix (PAF) 09-10		
	C1	C2	C3	F1	F2	F3
I6_F26	0.722	0.373	0.289	0.694	0.361	0.255
I7_F27	0.929	0.135	-0.096	0.928	0.120	-0.110
I8_F28	0.765	0.058	0.226	0.649	0.109	0.201
I9_F29	0.110	0.879	0.341	0.141	0.881	0.303
I10_F30	0.059	0.910	0.222	0.090	0.891	0.188
I11_F31	0.380	0.822	-0.095	0.374	0.714	-0.047
I12_F32	0.089	0.205	0.949	0.131	0.209	0.967
I13_F33	0.697	0.195	0.500	0.692	0.208	0.426
I14_F34	0.585	0.167	0.689	0.618	0.178	0.609

Rotation Method: Varimax with Kaiser Normalization.

5.1.3 Motivating Tasks

Our sampling adequacy tests for the Motivating tasks items do not support factor analysis in the individual years. After pooling the data adequacy becomes acceptable, but still weak. A two-factor solution is suggested in our analysis; however, previous validations of this construct showed that it was unidimensional.

From Table 16, all the items have means higher than neutral, which means they have some level of positive responses on all of the motivating tasks questions. Students have relatively strong agreement on items F4 and F7 to F9, indicating that they think the course blog allows them to learn things which they are interested in (F4) mainly by reading other students' posts and participating in discussions (F7, F8). Also, their creative thinking and original ideas are valued by the instructor (F9). However, the standard deviations are relative high. The data is reliable in each year and after pooling (α=0.730, 0.923, and 0.871).

Table 16 - Motivating Tasks Reliability Test

	Item Statistics						Reliability		
	Mean			Std. Deviation			Cronbach's Alpha		
	09	10	09-10	09	10	09-10	09	10	09-10
F1	4.620	3.889	4.318	1.557	1.900	1.701	0.730	0.923	0.871
F2	4.540	4.778	4.636	0.776	1.563	1.136			
F3	4.620	4.778	4.682	0.870	1.856	1.323	**Case valid**		
F4	5.460	5.000	5.273	0.967	1.732	1.316	**09**	**10**	**09-10**
F5	4.540	4.667	4.591	0.660	1.581	1.098			
F6	4.620	4.667	4.636	0.650	1.803	1.217	13/13	9/9	22/22
F7	5.080	5.778	5.364	1.382	1.202	1.329			
F8	5.230	4.889	5.091	1.423	1.965	1.630			
F9	5.620	5.667	5.636	0.870	1.323	1.049			
Scale Stat.	44.308	44.111	44.227	5.407	11.858	8.383			

In the correlation matrix (see Table 17) F7 has negative correlations with all other items, but other correlations seem reasonable and have no problem of multicollinearity. F7 is a negative wording question in final survey, which asks about whether students learn from blog mainly by reading the instructor's blog posts. We encourage students to choose their topics with interest to discuss on the blog and learn from their classmates' postings, and the instructor doesn't post topics for learning purpose. We expect to see low scores, but it seems students didn't pay enough attention when answering this question.

Table 17 - Motivating Tasks Correlation Matrix

Correlation Matrix

2009

	F1	F2	F3	F4	F5	F6	F7	F8	F9
F1	1.000								
F2	0.186	1.000							
F3	0.313	0.456	1.000						
F4	0.736	0.085	0.030	1.000					
F5	0.624	0.525	0.536	0.492	1.000				
F6	0.171	0.279	0.601	-0.092	0.522	1.000			
F7	0.015	0.036	-0.459	0.221	-0.140	-0.335	1.000		
F8	0.720	-0.122	-0.124	0.642	0.211	-0.166	0.456	1.000	
F9	0.497	0.085	0.229	0.724	0.246	0.159	0.096	0.482	1.000

2010

	F1	F2	F3	F4	F5	F6	F7	F8	F9
F1	1.000								
F2	0.748	1.000							
F3	0.843	0.799	1.000						
F4	0.722	0.923	0.700	1.000					
F5	0.693	0.876	0.824	0.867	1.000				
F6	0.791	0.769	0.834	0.841	0.745	1.000			
F7	-0.176	-0.296	-0.529	-0.240	-0.636	-0.212	1.000		
F8	0.867	0.886	0.815	0.918	0.872	0.800	-0.382	1.000	
F9	0.381	0.685	0.577	0.709	0.598	0.577	-0.367	0.657	1.000

2009-2010

	F1	F2	F3	F4	F5	F6	F7	F8	F9
F1	1.000								
F2	0.482	1.000							
F3	0.597	0.711	1.000						
F4	0.725	0.643	0.490	1.000					
F5	0.608	0.791	0.758	0.740	1.000				
F6	0.542	0.658	0.782	0.600	0.703	1.000			
F7	-0.117	-0.098	-0.418	-0.059	-0.350	-0.209	1.000		
F8	0.796	0.507	0.478	0.809	0.634	0.498	0.050	1.000	
F9	0.415	0.483	0.462	0.696	0.485	0.451	-0.106	0.577	1.000

Although data remains reliable before and after pooling, the low KMOs for each single year (0.463 and 0.470) suggest that partial correlations among variables are very small, and so factor analysis is not appropriate for each year; however, KMO of the pooled data (0.744) becomes moderate, and its correlation matrix is not an identity matrix (χ^2=136.318, p=.000). The determinant is lower than 0.00001, which means linear dependency exists among items, makes the result of factor analysis instable. The high similar or identical responses from the survey could be one reason for this problem, and the small data size could be another. F7 has low communality scores in PAF, and F9 has low communality scores both in PCA and PAF (see Table 19). This question may need to be reworded in future study.

Both PCA and PAF provide a two-factor solution. From Greene et al.'s research we know "Motivating Tasks" is a validated psychometric scale [132], and so we expect to see a one factor solution. All items have major loadings on the first factor except F7, while F2, F3, and F5 to F7 have loadings on the second factor. The heavy cross loadings of items along with the determinant of item correlations strongly indicate that current data size is too small to provide a stable result in a factor analysis.

Table 18 - Motivation Tasks Factor Analysis

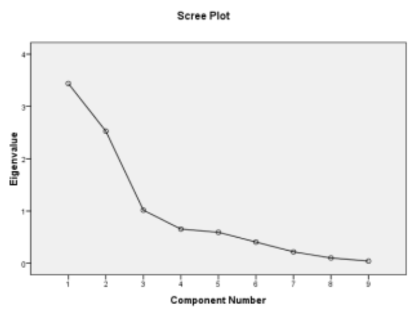
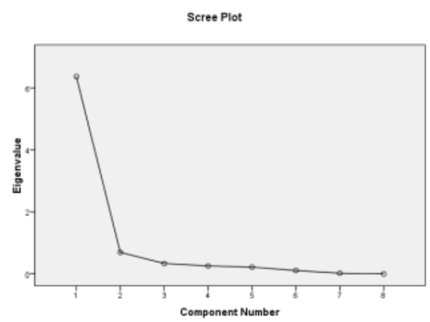
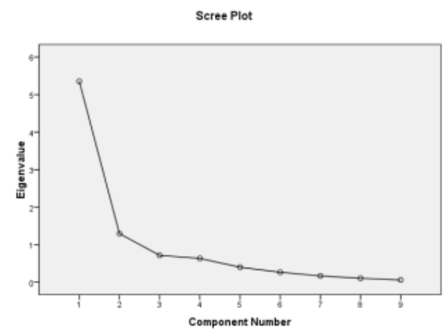
Factor Analysis	2009	2010	09-10
Correlation	Determinant = .001	not positive definite, Remove F7_LearnByReadingPosts and get Determinant = 1.19E-007	Determinant = .000
KMO	.463	.470	.744
Bartlett's Test of Sphericity	Approx.Chi-Square= 54.143, df=36, sig.= .027	Approx.Chi-Square= 71.748, df= 28, sig.=.000	Approx.Chi-Square= 136.318, df=36, sig.=.000
Extration sums of Sqared Loadings(PCA)	Cumulative =34.738, 57.761, 77.576%	Cumulative = 79.610%	Cumulative= 44.621, 73.892 %
Extration sums of Sqared Loadings(PAF)	Cumulative = 31.747, 49.369, 66.484%	Cumulative = 77.047%	Cumulative= 42.354, 66.851%
Scree Plot			

Table 19 - Communalities of Motivation Tasks

	Communalities (PCA)			Communalities (PAF)					
	2009	2010	09-10	2009		2010		09-10	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
F1	0.823	0.729	0.672	0.864	0.808	0.960	0.681	0.775	0.608
F2	0.865	0.885	0.664	0.558	0.628	0.992	0.881	0.749	0.615
F3	0.772	0.807	0.842	0.655	0.704	0.997	0.775	0.855	0.928
F4	0.846	0.883	0.856	0.901	0.813	0.999	0.878	0.875	0.890
F5	0.794	0.833	0.836	0.832	0.738	0.990	0.812	0.842	0.817
F6	0.637	0.799	0.694	0.696	0.470	0.994	0.765	0.702	0.650
F7	0.817		0.733	0.602	0.634			0.468	0.219
F8	0.808	0.920	0.835	0.829	0.753	0.986	0.930	0.791	0.868
F9	0.620	0.513	0.518	0.804	0.436	0.948	0.443	0.629	0.421

Initial in PCA are 1s.

Table 20 - Component (Factor) Matrix of Motivation Tasks

	Component Matrix (PCA)					Factor Matrix (PAF)				
	2009*		2010	09-10 *		2009*		2010	09-10 *	
	C1	C2	C1	C1	C2	F1	F2	F1	F1	F2
F1	0.865	0.144	0.854	0.801	0.173	0.860	0.140	0.825	0.737	0.256
F2	-0.032	0.040	0.941	0.685	0.441	0.002	0.034	0.938	0.568	0.541
F3	0.127	0.734	0.898	0.551	0.733	0.125	0.662	0.880	0.424	0.865
F4	0.908	-0.110	0.940	0.918	0.117	0.889	-0.117	0.937	0.924	0.188
F5	0.462	0.366	0.913	0.708	0.579	0.460	0.321	0.901	0.633	0.646
F6	0.034	0.694	0.894	0.628	0.547	0.033	0.549	0.875	0.521	0.616
F7	0.179	-0.865		0.152	-0.843	0.176	-0.773		0.049	-0.465
F8	0.829	-0.345	0.959	0.913	-0.024	0.800	-0.326	0.964	0.930	0.053
F9	0.777	0.129	0.716	0.709	0.125	0.653	0.066	0.665	0.611	0.220

* Rotation Method: Varimax with Kaiser Normalization.

5.1.4 Autonomy Support

Items for Autonomy Support also exhibit a sample size problem. Data is reliable but not appropriate for factor analysis in 2009. Data in 2010 has a better structure than in 2009. After pooling we find a one-factor solution, but the score of total explained variance is low, which means there are still fair amount of information hasn't been accounted by extracted factors.

Item F10, F11 and F13 have high mean scores (Table 21), which means generally students agree that they feel in control of their learning on the blog (F10), get to choose what they want to discuss (F11), and get a chance to correct their mistakes on the blog (F13). A lower mean of F12 reflects students didn't think their instructor give enough discussion about plans to meet the goal for using course blog. The items with 22 valid cases have a moderate reliability (α=0.777). The correlations among items (see Table 22) are from low to intermediate, among which F14 has weak relationship with F11 (r=0.198) and F13 (r=0.141).

Table 21 - Reliability Test for Autonomy Support

	Item Statistics						Reliability		
	Mean			Std. Deviation			Cronbach's Alpha		
	09	10	09-10	09	10	09-10	09	10	09-10
F10	5.385	6.000	5.636	0.768	0.866	0.848	0.644	0.856	0.777
F11	6.462	6.222	6.364	0.660	0.833	0.727			
F12	3.615	4.222	3.864	0.961	1.716	1.320	**Case valid**		
F13	4.923	5.778	5.273	1.382	1.202	1.352	**09**	**10**	**09-10**
F14	4.538	4.778	4.636	1.127	1.563	1.293	13/13	9/9	22/22
Sum	24.923	27.000	25.773	3.252	5.123	4.140			

Table 22 - Autonomy Support Correlation Matrix

Correlation Matrix					
2009					
	F10	**F11**	**F12**	**F13**	**F14**
F10	1.000				
F11	0.607	1.000			
F12	-0.009	-0.091	1.000		
F13	0.580	0.590	0.478	1.000	
F14	0.319	0.086	0.130	0.136	1.000
2010					
	F10	**F11**	**F12**	**F13**	**F14**
F10	1.000				
F11	0.693	1.000			
F12	0.841	0.748	1.000		
F13	0.480	0.804	0.572	1.000	
F14	0.831	0.330	0.720	0.103	1.000
2009-2010					
	F10	**F11**	**F12**	**F13**	**F14**
F10	1.000				
F11	0.534	1.000			
F12	0.507	0.352	1.000		
F13	0.589	0.573	0.529	1.000	
F14	0.569	0.198	0.500	0.141	1.000

Factor analysis is not suggested for the data in 2009, while in 2010 the data adequacy is low but acceptable (KMO=.698; χ^2=28.417, p=.002), and a two-factor solution is extracted (see Table 23). After pooling the data adequacy is still acceptable (KMO=.652; χ^2=37.447, p=.000), and a one-factor solution is suggested. However, communality for each item is relatively low except for F10, indicating a substantial portion of variance is unexplained.

Table 23 - Autonomy Support Factor Analysis

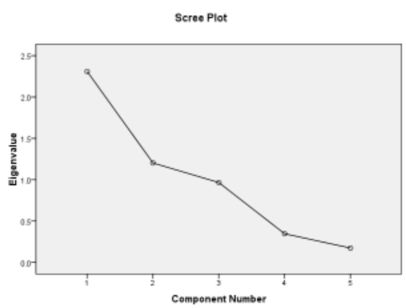
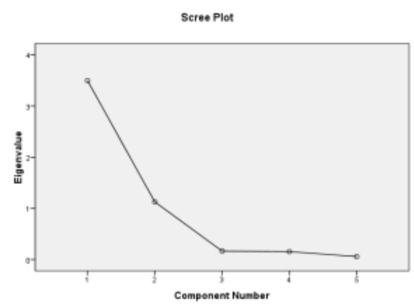
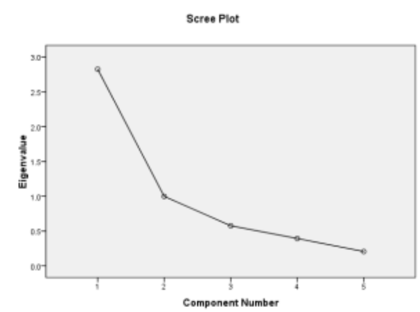
Factor Analysis	**2009**	**2010**	**09-10**
Correlation	Determinant = .162	Determinant = .006	Determinant = .132
KMO	.499	.698	.652
Bartlett's Test of Sphericity	Approx.Chi-Square= 17.289, df=10, sig.= .068	Approx.Chi-Square= 28.417, df=10, sig.= .002	Approx.Chi-Square= 37.447, df=10, sig.=.000
Extration sums of Sqared Loadings(PCA)	Cumulative =42.272, 70.260%	Cumulative = 48.467, 92.488%	Cumulative= 56.503%
Component(PCA)	Two components	Two components	One component
Extration sums of Sqared Loadings(PAF)	Cumulative = 37.552, 60.824%	Cumulative = 45.496, 87.874%	Cumulative= 46.748%
Factors(PAF)	Two factors	Two factors	One factor
Scree Plot			

Table 24 - Communalities of Autonomy Support

	Communalities (PCA)			Communalities (PAF)					
	2009	2010	09-10	2009		2010		09-10	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
F10	0.784	0.933	0.747	0.542	0.641	0.890	0.896	0.618	0.746
F11	0.791	0.913	0.506	0.558	0.617	0.827	0.907	0.389	0.377
F12	0.943	0.892	0.593	0.492	0.920	0.820	0.833	0.465	0.466
F13	0.831	0.922	0.598	0.700	0.806	0.702	0.763	0.575	0.491
F14	0.165	0.965	0.381	0.150	0.057	0.866	0.994	0.501	0.256

* Initial in PCA are 1s.

Table 25 - Component (Factor) Matrix of Autonomy Support

	Component Matrix (PCA)					Factor Matrix (PAF)				
	2009*		2010*		09-10	2009*		2010*		09-10
	C1	C2	C1	C2	C1	F1	F2	F1	F2	F1
F10	0.880	0.098	0.864	0.432	0.864	0.800	-0.018	0.821	0.471	0.864
F11	0.888	-0.046	0.356	0.886	0.711	0.780	-0.096	0.321	0.897	0.614
F12	-0.122	0.963	0.761	0.559	0.770	0.018	0.959	0.704	0.581	0.683
F13	0.678	0.609	0.076	0.957	0.773	0.762	0.474	0.089	0.869	0.701
F14	0.276	0.298	0.982	-0.006	0.617	0.219	0.097	0.997	0.018	0.506

* Rotation Method: Varimax with Kaiser Normalization.

5.1.5 Mastery Evaluation

Mastery Evaluation was shown to be a unidimensional factor in Greene's model [132], but our result shows that factor analysis is not appropriate for our data. Items have low reliabilities and low sampling adequacy, and most of the correlations are very weak. Overall speaking, a one-factor solution is not suggested. This is somewhat unsurprising, as "Mastery Evaluation" explores whether students feel that instructor grades them based on their true knowledge and abilities learned from the course, without comparing to other students. University of Alberta uses a standardized grade curve for all courses, so it is reasonable to find that students do not perceive themselves to be evaluated purely on their own mastery of the class material.

Generally, the means of F15, F18, F21 F23 and F25 indicate that students believe they don't have to compete against each other (F18), not only top students can keep up with discussions (F25), and many of them can get high grades on the blog if they meet requirements (F15), but they cannot redo their work to improve the grades (F21), and instructor should pay more attention to whether students are improving or not (F23). Means of F16 and F22 indicate students have neutral opinions on whether instructor use more than one ways to grades them (F16), and the fairness of their grades (F22). The means of the rest items reflect that students have some degree of agreement that their privacy of grades are protected (F19), they are treated with respect when they make mistakes (F20), and they get guidelines for how they will be graded (F24). F18, F24 and F25 have higher std.

deviations, illustrate students' opinions are more dispersed on these items than others.

We decided to remove question 17 from the experiment, because it was a question reflect no real situation. The question asked how students think about the final exam, but they would not know the content of the exam by then because the survey was taken before the exam happened. The answers gathered probably only reflect students' assumptions and guess, which is meaningless and not useful for the research.

We found that data reliability was low (α=0.583). From the correlation matrix we can see most of the correlations are weak, and there are several negative relationships among these items. The KMOs in Table 28 suggest factor analysis is not a good idea even for the pooled data.

Table 26 - Master Evaluation Reliability Test

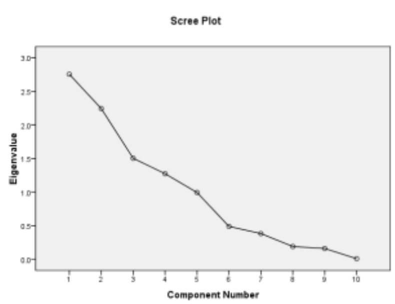
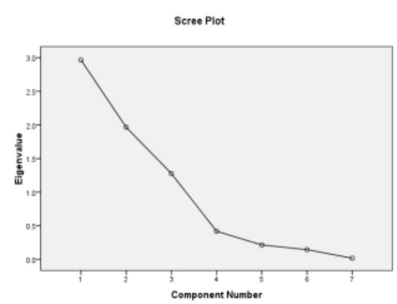
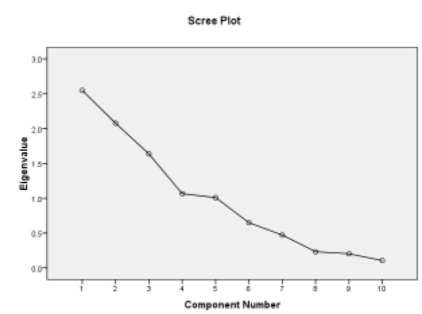
	Item Statistics						Reliability		
	Mean			Std. Deviation			Cronbach's Alpha		
	09	10	09-10	09	10	09-10	09	10	09-10
F15	4.538	5.250	4.810	1.266	1.581	1.401	0.264	0.787	0.583
F16	4.385	3.875	4.190	1.193	1.126	1.167			
F18	4.000	6.000	4.762	1.472	1.069	1.640	**Case Valid**		
F19	4.923	4.750	4.857	1.038	1.165	1.062	**09**	**10**	**09-10**
F20	5.308	5.125	5.238	0.947	1.126	0.995	13/13	8/9	21/22
F21	2.769	2.875	2.810	1.363	1.356	1.327			
F22	4.154	4.500	4.286	0.376	1.069	0.717			
F23	3.538	3.000	3.333	0.776	1.773	1.238			
F24	5.077	5.375	5.190	1.656	1.598	1.601			
F25	4.769	5.625	5.095	1.641	1.302	1.546			
Scale Stat.	43.462	46.375	44.571	4.465	7.836	5.963			

Table 27 - Correlation Matrix of Master Evaluation

Correlation Matrix of Master Evaluation										
2009										
	F15	**F16**	**F18**	**F19**	**F20**	**F21**	**F22**	**F23**	**F24**	**F25**
F15	1.000									
F16	0.403	1.000								
F18	0.447	0.047	1.000							
F19	0.098	0.295	-0.109	1.000						
F20	0.128	0.034	0.000	0.280	1.000					
F21	0.319	-0.043	0.415	-0.426	-0.457	1.000				
F22	-0.013	-0.143	0.603	0.033	0.090	0.238	1.000			
F23	-0.150	-0.512	-0.146	-0.565	-0.131	-0.030	-0.308	1.000		
F24	0.257	-0.269	-0.068	-0.578	-0.016	0.156	-0.155	0.613	1.000	
F25	0.265	0.603	0.242	-0.011	-0.165	-0.138	0.198	-0.156	-0.208	1.000
2010										
	F15	**F16**	**F18**	**F19**	**F20**	**F21**	**F22**	**F23**	**F24**	**F25**
F15	1.000									
F16	0.341	1.000								
F18	0.676	0.000	1.000							
F19	0.504	-0.027	0.574	1.000						
F20	0.140	0.465	0.000	0.572	1.000					
F21	-0.383	-0.012	-0.197	0.158	0.667	1.000				
F22	0.254	-0.059	0.375	0.803	0.653	0.345	1.000			
F23	-0.051	0.358	-0.075	0.553	0.930	0.594	0.754	1.000		
F24	0.580	-0.050	0.920	0.518	-0.109	-0.371	0.460	-0.050	1.000	
F25	0.746	-0.329	0.821	0.588	-0.158	-0.354	0.359	-0.247	0.764	1.000

Correlation Matrix of Master Evaluation										
2009-2010										
	F15	**F16**	**F18**	**F19**	**F20**	**F21**	**F22**	**F23**	**F24**	**F25**
F15	1.000									
F16	0.299	1.000								
F18	0.545	-0.106	1.000							
F19	0.250	0.184	0.037	1.000						
F20	0.106	0.217	-0.055	0.412	1.000					
F21	0.033	-0.040	0.208	-0.198	-0.002	1.000				
F22	0.206	-0.128	0.443	0.450	0.390	0.270	1.000			
F23	-0.135	0.023	-0.205	0.114	0.500	0.284	0.450	1.000		
F24	0.396	-0.208	0.228	-0.160	-0.061	-0.029	0.212	0.193	1.000	
F25	0.471	0.239	0.463	0.161	-0.178	-0.186	0.290	-0.226	0.114	1.000

Table 28 - Master Evaluation Factor Analysis[2]

Factor Analysis	**2009**	**2010**	**09-10**
Correlation	Determinant = .001	Not positive definite, and Determinant = .000. Remove F23, 24, 25 and get Determinant = .002	Determinant = .014
KMO	.122	.325	.399
Bartlett's Test of Sphericity	Approx.Chi-Square= 58.312, df=45, sig.= .088	Approx.Chi-Square= 24.922, df= 21, sig.= .251	Approx.Chi-Square= 67.417, df= 45, sig.=.017
Extration sums of Sqared Loadings(PCA)	Cumulative = 23.130, 43.217, 62.994, 77.756%	Cumulative = 35.009, 69.843, 88.726%	Cumulative= 23.077, 44.738, 58.117, 70.820, 83.385%
Component(PCA)	Four components	Three components	Five components
Extration sums of Sqared Loadings(PAF)	Cumulative = 19.919, 37.158, 53.618, 65.130%	Cumulative = 33.009, 65.893, 83.079%	Cumulative= 19.702, 38.370, 48.466, 58.316, 67.642%
Factors(PAF)	Four factors	Three factors	Five factors
Scree Plot			

[2] Factor analysis is not suggested, so the results in this table are not stable. It may change once the data size changes.

Table 29 - Communalities for Master Evaluation[3]

	Communalities (PCA)			Communalities (PAF)					
	2009	2010	09-10	2009		2010		09-10	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
F15	0.838	0.889	0.815	0.948	0.637	0.732	0.747	0.692	0.809
F16	0.874	0.967	0.917	0.899	0.990	0.886	0.889	0.428	0.532
F18	0.815	0.787	0.817	0.843	0.780	0.825	0.722	0.642	0.697
F19	0.739	0.900	0.800	0.934	0.598	0.905	0.886	0.583	0.559
F20	0.860	0.984	0.737	0.855	0.701	0.971	0.993	0.550	0.540
F21	0.697	0.824	0.920	0.943	0.519	0.900	0.798	0.482	0.660
F22	0.779	0.860	0.890	0.939	0.573	0.823	0.782	0.769	0.994
F23	0.746		0.819	0.850	0.623			0.606	0.719
F24	0.838		0.941	0.931	0.793			0.540	0.783
F25	0.591		0.682	0.953	0.299			0.591	0.471

* Initial in PCA are 1s.

[3] Factor analysis is not suggested, so the results in this table are not stable. It may change once the data size changes.

Table 30 - Component (Factor) Matrix for Master Evaluation[4]

		2009*				2010*			09-10*				
		C1	**C2**	**C3**	**C4**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**	**C4**	**C5**
PCA	**F15**	0.314	0.359	0.727	0.287	-0.102	0.860	0.373	0.719	0.089	-0.021	0.394	0.366
	F16	-0.316	-0.132	0.870	0.006	0.066	0.045	0.980	0.096	0.097	-0.016	0.938	-0.139
	F18	0.027	0.876	0.218	0.009	0.000	0.883	-0.079	0.839	-0.005	0.263	-0.191	0.083
	F19	-0.708	-0.132	0.130	0.450	0.607	0.723	-0.097	0.276	0.689	-0.380	0.057	-0.318
	F20	-0.051	0.030	-0.055	0.924	0.893	0.074	0.424	-0.141	0.813	-0.006	0.235	0.017
	F21	0.279	0.588	0.079	-0.516	0.820	-0.388	-0.036	0.042	0.060	0.955	-0.016	-0.047
	F22	-0.286	0.819	-0.163	0.021	0.773	0.488	-0.159	0.449	0.727	0.237	-0.316	0.061
	F23	0.763	-0.241	-0.303	-0.116				-0.352	0.690	0.334	0.017	0.326
	F24	0.910	-0.017	-0.022	0.089				0.192	0.023	-0.040	-0.140	0.939
	F25	-0.194	0.057	0.707	-0.222				0.785	-0.049	-0.205	0.144	-0.004
		F1	**F2**	**F3**	**F4**	**F1**	**F2**	**F3**	**F1**	**F2**	**F3**	**F4**	**F5**
PAF	**F15**	0.263	0.661	0.314	0.181	-0.114	0.787	0.337	0.693	0.075	0.356	-0.005	0.443
	F16	-0.328	0.923	-0.174	-0.012	0.068	0.043	0.939	0.075	0.109	-0.138	-0.042	0.702
	F18	0.030	0.233	0.850	-0.036	-0.036	0.847	-0.051	0.788	-0.009	0.098	0.222	-0.134
	F19	-0.638	0.132	-0.105	0.403	0.558	0.753	-0.089	0.226	0.593	-0.210	-0.304	0.140
	F20	-0.048	-0.022	0.036	0.835	0.898	0.114	0.417	-0.125	0.688	0.009	0.018	0.227
	F21	0.249	0.108	0.467	-0.477	0.822	-0.345	-0.058	0.033	0.054	-0.021	0.809	-0.035
	F22	-0.228	-0.097	0.715	0.012	0.706	0.513	-0.139	0.466	0.778	0.059	0.222	-0.344
	F23	0.686	-0.312	-0.209	-0.107				-0.347	0.645	0.279	0.324	0.002
	F24	0.888	-0.010	-0.039	0.049				0.184	0.014	0.853	-0.013	-0.144
	F25	-0.174	0.495	0.084	-0.130				0.651	-0.013	0.016	-0.180	0.118

* Rotation Method: Varimax with Kaiser Normalization.

[4] Factor analysis is not suggested, so the results in this table are not stable. It may change once the data size changes.

5.2 Results for CMPE 440 Surveys

5.2.1 Attitude toward using the Wiki

The items for Attitude towards the wiki exhibit high reliabilities for each year and after pooling; items have relatively high correlations with others; sampling adequacies are good; and a one-factor solution is suggested after pooling the data, with the variance of each item well explained. Overall speaking, the result confirms the hypothesis for the factor "Attitude" in this model.

By taking a look at the means of items (Table 31), on average students exhibit clearly positive attitudes toward using the wiki. The pooled data has an excellent reliability (α=.968) for the 20 valid responses. In the correlation matrix (Table 32), all correlations range from intermediate to high, and some are extremely high (e.g. ATT4 and ATT5 with r=0.94). Sometimes it will lead to problems such as items have high similarities, but the determinant in Table 33 indicates that the matrix is positive definite, and there exists no linear relationship among items. The data adequacy (KMO=0.8; χ^2=111.481, p=.000) of the pooled data indicates a factor analysis is appropriate to be performed.

Both PCA and PAF on the pooled data suggest that all the items have heavy loadings on the extracted single factor. The total explained variance and communalities are relative high. Compare the result from the pooled data to the data in 2009, we found in 2009 item ATT1 cannot be distinguished from ATT5, because there exists two responses with exactly the same answers in the five questions. We infer that the small data size decreased the robustness of the result. Results should be improved if the data size increases. However, there are only five items need to be analyzed, and the 20 valid cases seem to support our hypothesis that there is only one latent factor.

Table 31 - Reliability Test for Attitude toward using Wiki

	Item Statistics						Reliability		
	Mean			Std. Deviation			Cronbach's Alpha		
	09	10	0910	09	10	0910	09	10	0910
ATT1	6.27	5.33	5.85	0.79	1.66	1.31	0.924	0.953	0.951
ATT2	6.45	5.22	5.90	0.69	1.64	1.33			
ATT3	6.55	5.56	6.10	0.52	1.13	0.97	Case valid		
ATT4	6.27	5.72	6.03	0.79	1.25	1.03	09	10	0910
ATT5	6.27	5.78	6.05	0.79	1.20	1.00	11/11	9/9	20/20
Scale Statistics	31.82	27.61	29.93	3.16	6.40	5.21			

Table 32 - Correlation Matrix for Attitude toward using Wiki

Correlation Matrix

2009

	ATT1	ATT2	ATT3	ATT4	ATT5
ATT1_Good_or_Bad	1.00				
ATT2_Wise_or_Foolish	0.49	1.00			
ATT3_Favorable_or_Unfavorable	0.82	0.63	1.00		
ATT4_Beneficial_or_Harmful	0.84	0.49	0.82	1.00	
ATT5_Positive_or_Negative	1.00	0.49	0.82	0.84	1.00

2010

	ATT1	ATT2	ATT3	ATT4	ATT5
ATT1_Good_or_Bad	1.00				
ATT2_Wise_or_Foolish	0.70	1.00			
ATT3_Favorable_or_Unfavorable	0.89	0.87	1.00		
ATT4_Beneficial_or_Harmful	0.71	0.85	0.92	1.00	
ATT5_Positive_or_Negative	0.73	0.85	0.93	0.99	1.00

2009-2010

	ATT1	ATT2	ATT3	ATT4	ATT5
ATT1_Good_or_Bad	1.00				
ATT2_Wise_or_Foolish	0.71	1.00			
ATT3_Favorable_or_Unfavorable	0.88	0.86	1.00		
ATT4_Beneficial_or_Harmful	0.76	0.77	0.87	1.00	
ATT5_Positive_or_Negative	0.81	0.75	0.87	0.94	1.00

Table 33 - Factor Analysis for Attitude toward using Wiki

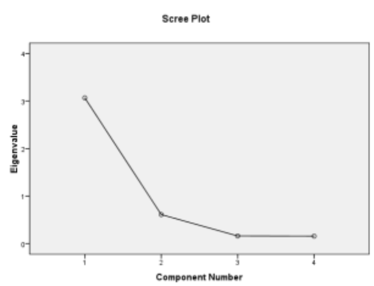
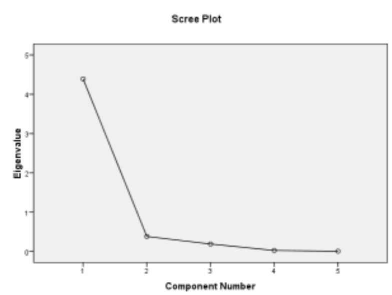
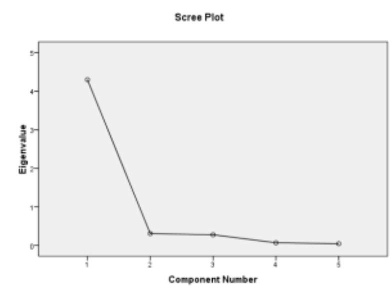
Factor Analysis	**2009**	**2010**	**09-10**
Correlation	Not positive definite, Determinant = .000. Remove ATT_Positive: Determinant = .048	Determinant = 6.64E-005	Determinant = .001
KMO	.791	.790	.800
Bartlett’s Test of Sphericity	Approx.Chi-Square=23.821 , df=6, sig.=.001	Approx.Chi-Square=52.913 , df=10, sig.=.000	Approx.Chi-Square=111.481, df=10, sig.=.000
Extration sums of Sqared Loadings(PCA)	Cumulative=76.715%	Cumulative=87.798%	Cumulative=85.972%
Component(PCA)	One component	One component	One component
Extration sums of Sqared Loadings(PAF)	Cumulative=70.689%	Cumulative= 85.134 %	Cumulative= 82.659%
Factors(PAF)	One factor	One factor	One factor
Scree Plot			

Table 34 - Communalities for Attitude toward using Wiki

	Communalities (PCA)			Communalities (PAF)					
	2009	2010	09-10	2009		2010		09-10	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
ATT1	0.832	0.735	0.810	0.756	0.788	0.865	0.640	0.815	0.747
ATT2	0.516	0.836	0.779	0.404	0.351	0.786	0.777	0.760	0.703
ATT3	0.888	0.967	0.936	0.783	0.900	0.965	0.992	0.917	0.949
ATT4	0.832	0.920	0.880	0.756	0.788	0.984	0.913	0.907	0.855
ATT5		0.932	0.894			0.987	0.934	0.910	0.878

Initial in PCA are 1s.

Table 35 – Component (Factor) Matrix for Attitude toward using Wiki

	Component Matrix (PCA)			Factor Matrix (PAF)		
	2009	2010	09-10	2009	2010	09-10
	C1	C1	C1	F1	F1	F1
ATT1	0.912	0.858	0.9	0.888	0.8	0.865
ATT2	0.718	0.914	0.883	0.592	0.882	0.839
ATT3	0.942	0.983	0.967	0.949	0.996	0.974
ATT4	0.912	0.959	0.938	0.888	0.956	0.925
ATT5		0.965	0.945		0.966	0.937

5.2.2 Perceived Usefulness of the Wiki

Perceived Usefulness is an important factor in Davis' TAM theory [8], and we use it to reflect the degree of a student's belief that use wiki can help to increase his performance in the project course. Our results indicate data is reliable for the factor analysis, and a one-factor solution is suggested. All items have major loadings on the factor, which means items can explain the factor well.

From item means in Table 36 we believe students have some degree of agreement that using the wiki improves their performance and the quality of their work, a lower score of item USEF7 indicates that students are neutral on whether the wiki can help them to finish more work. Students in 2009 seem to have an overall higher degree of beliefs that Wiki is useful, because the means in 2009 are higher than in 2010. 20 valid cases provide a high level of reliability (α=0.960) with eight items. After pooling the item correlations range from intermediate to high.

Table 36 - Reliability Test for Perceived Usefulness of Wiki

	Item Statistics						Reliability		
	Mean			Std. Deviation			Cronbach's Alpha		
	09	10	0910	09	10	0910	09	10	0910
USEF1	5.273	5.111	5.200	0.905	1.269	1.056	0.900	0.985	0.960
USEF2	5.636	5.111	5.400	1.206	1.167	1.188			
USEF3	5.091	4.333	4.750	1.221	1.414	1.333	Case valid		
USEF4	5.091	4.333	4.750	0.944	1.414	1.209	09	10	0910
USEF5	5.182	4.556	4.900	0.982	1.740	1.373	11/11	9/9	20/20
USEF6	5.000	4.778	4.900	1.265	1.856	1.518			
USEF7	4.455	4.444	4.450	1.214	1.740	1.432			
USEF8	5.636	4.667	5.200	1.027	1.732	1.436			
Scale Stat.	41.364	37.333	39.550	6.772	11.874	9.367			

An intermediate data adequacy (KMO=0.771; χ^2=178.430, p=.000) suggests a factor analysis on the pooled data is appropriate, but not on the individual years (see Table 38). A one-factor solution is suggested by both PCA and PAF. All the items have major loadings on the latent factor, range from 0.731 to 0.974 in PCA and 0.68 to 0.987 in PAF. Communalities (see Table 39) are relative high except item USEF1 (h^2=0.534 in PCA; h^2=0.462 in PAF). Similarly, factor loadings (see Table 40) of items are high except USEF1 (0.731 in PCA, and 0.68 in PAF). This means almost half of the variance of USEF1 is not accounted for by the latent factor. Overall speaking, factor Perceived Usefulness of Wiki is well represented by the eight items.

Table 37 - Correlation Matrix for Perceived Usefulness of Wiki

2009

	USEF1	USEF2	USEF3	USEF4	USEF5	USEF6	USEF7	USEF8
USEF1	1.000							
USEF2	0.558	1.000						
USEF3	0.156	0.704	1.000					
USEF4	-0.032	0.471	0.513	1.000				
USEF5	0.164	0.737	0.652	0.736	1.000			
USEF6	0.612	0.590	0.388	0.000	0.483	1.000		
USEF7	0.058	0.739	0.779	0.659	0.679	0.195	1.000	
USEF8	0.440	0.932	0.667	0.657	0.866	0.616	0.788	1.000

2010

	USEF1	USEF2	USEF3	USEF4	USEF5	USEF6	USEF7	USEF8
USEF1	1.000							
USEF2	0.835	1.000						
USEF3	0.812	0.884	1.000					
USEF4	0.812	0.884	1.000	1.000				
USEF5	0.817	0.951	0.931	0.931	1.000			
USEF6	0.861	0.937	0.889	0.889	0.972	1.000		
USEF7	0.824	0.958	0.897	0.897	0.982	0.963	1.000	
USEF8	0.815	0.949	0.919	0.919	0.982	0.985	0.968	1.000

2009-2010

	USEF1	USEF2	USEF3	USEF4	USEF5	USEF6	USEF7	USEF8
USEF1	1.000							
USEF2	0.688	1.000						
USEF3	0.523	0.798	1.000					
USEF4	0.495	0.697	0.809	1.000				
USEF5	0.595	0.833	0.820	0.872	1.000			
USEF6	0.768	0.753	0.663	0.559	0.803	1.000		
USEF7	0.529	0.817	0.807	0.768	0.854	0.675	1.000	
USEF8	0.666	0.907	0.825	0.849	0.945	0.830	0.850	1.000

Table 38 - Factor Analysis for Perceived Usefulness of Wiki

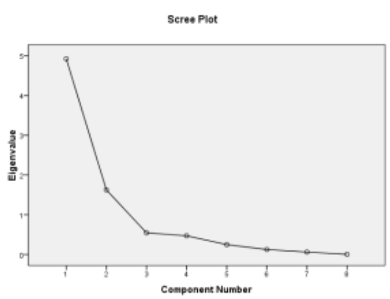
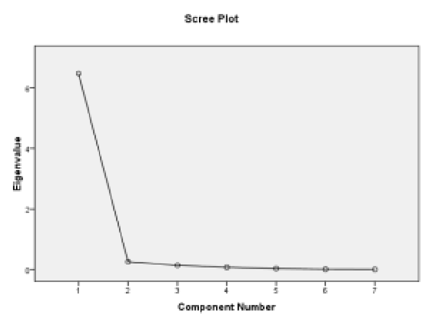
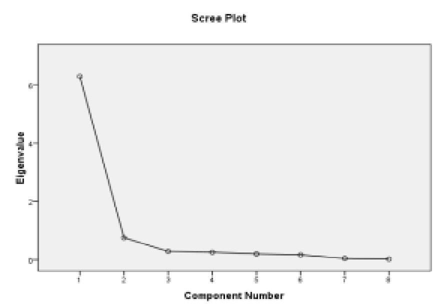
Factor Analysis	**2009**	**2010**	**09-10**
Correlation	Determinant = 1.00E-005	Not positive definite, Remove USEF4_CriticalAspects: Determinant = 3.67E-008	Determinant = 1.00E-005
KMO	.429	.805	.771
Bartlett's Test of Sphericity	Approx.Chi-Square=74.820, df=28, sig.=.000	Approx.Chi-Square=82.746, df=21, sig.=.000	Approx.Chi-Square=178.430, df=28, sig.=.000
Extration sums of Sqared Loadings(PCA)	Cumulative= 52.443%, 81.865%	Cumulative= 92.483%	Cumulative= 78.583%
Component(PCA)	Two components	One component	One component
Extration sums of Sqared Loadings(PAF)	Cumulative= 48.783, 75.238%	Cumulative= 91.350%	Cumulative= 75.892%
Factors(PAF)	Two factors	One factor	One factor
Scree Plot			

Table 39 - Communalities for Perceived Usefulness of Wiki

	Communalities (PCA)			Communalities (PAF)					
	2009	**2010**	**09-10**	**2009**		**2010**		**09-10**	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
USEF1	0.796	0.780	0.534	0.744	0.594	0.881	0.724	0.727	0.462
USEF2	0.903	0.938	0.845	0.987	0.910	0.939	0.929	0.907	0.827
USEF3	0.684	0.885	0.785	0.943	0.596	0.929	0.857	0.804	0.750
USEF4	0.767		0.738	0.957	0.665			0.917	0.694
USEF5	0.813	0.974	0.911	0.883	0.768	0.986	0.981	0.939	0.920
USEF6	0.802	0.965	0.725	0.965	0.697	0.989	0.967	0.901	0.674
USEF7	0.833	0.962	0.801	0.959	0.800	0.972	0.963	0.786	0.771
USEF8	0.952	0.969	0.949	0.996	0.990	0.990	0.973	0.963	0.975

Initial in PCA are 1s.

Table 40 - Component (Factor) Matrix for Perceived Usefulness of Wiki

	Component Matrix (PCA)				Factor Matrix (PAF)			
	2009*		2010	09-10	2009*		2010	09-10
	1	2	1	1	1	2	1	1
USEF1	-0.011	0.892	0.883	0.731	0.008	0.771	0.851	0.680
USEF2	0.725	0.614	0.968	0.919	0.710	0.636	0.964	0.909
USEF3	0.795	0.228	0.941	0.886	0.733	0.242	0.926	0.866
USEF4	0.861	-0.163		0.859	0.808	-0.111		0.833
USEF5	0.861	0.267	0.987	0.954	0.830	0.282	0.990	0.959
USEF6	0.200	0.873	0.982	0.851	0.189	0.813	0.984	0.821
USEF7	0.910	0.066	0.981	0.895	0.890	0.083	0.981	0.878
USEF8	0.829	0.515	0.984	0.974	0.831	0.547	0.987	0.987

* Rotation Method: Varimax with Kaiser Normalization.

5.2.3 Perceived Ease of Use of Wiki

Perceived Ease of Use is another important factor in Davis' TAM theory [8]. Davis and many others have found that the ten items measure one single common factor, but we could not replicate this finding. We believe one possible reason is that the negative wording questions in the survey lead to errors, and the limited size makes the data became more sensitive. Though the pooled data is reliable and data adequacy is acceptable, there are several negative correlations among the items, and a three-factor solution is suggested.

Items designed for Perceived Ease of Use are different from other factors, because we have both positive and negative wording questions. Positive wording questions are the even numbered items (EOU2, EOU4, EOU6, EOU8, EOU10), and negative wording questions are the odd numbered items (EOU1, EOU3, EOU5, EOU9). From the means of item EOU1, EOU3, and EOU5 (see Table 41) we conclude that students have neutral opinions about if the Wiki is cumbersome to use, frustrating, rigid and inflexible to interact with. They also agree interacting with and become skillful at using Wiki requires some effort (EOU7 and EOU9). Means from the even numbered the items indicate students have certain level of agreement that learning to use and perform with Wiki is easy, the actions are easy to remember, and the interactions with Wiki are clear and understandable. This inconsistency, and the fact that all of the negative wording questions have lower means than the positive wording questions, indicates there is a problem exists. It appears that a number of students did not read and reflect on the survey items. For example, one student answered all ease of use questions with the same score. Furthermore, when data size is small, the data becomes more sensitive, makes it a serious problem in this research. However, the pooled data still provides a good reliability with 20 valid responses. Taking a look at the correlations among items (Table 42), almost half of the correlations are lower than 0.3, and some are negative. This indicates some items have weak or no relationships with others.

From Table 43 we conclude factor analysis is not suggested for the data from each year, but it seems to be appropriate for the pooled data. Pooled data has acceptable adequacy and the correlation matrix is not an identity matrix (KMO=.657; χ^2=137.706, p=.000); however, both PCA and PAF suggest three-factor solutions, which is far away from our expectation. We notice the data structure changes for every year (Table 45). For the pooled data, all the even numbers of items have major loadings on the first factor or component after rotation. EOU1, EOU3, and EOU5 load heavily on the second factor; EOU7 and EOU9 have major contributions for the third factor. There are no cross loadings among factors. The communalities of items are reasonable, and the lowest are EOU4 (h^2=0.636 in PCA, 0.49 in PAF). Basically the first factor includes all the positive wording questions; the second factor includes negative wording questions except the two questions relevant to effort; and the last factor only investigate students' effort needed for using Wiki.

Table 41 - Reliability Test for Perceived Ease of Use of Wiki

	Item Statistics						Reliability		
	Mean			Std. Deviation			Cronbach's Alpha		
	09	10	0910	09	10	0910	09	10	0910
EOU1_Cumbersome	4.000	4.000	4.000	1.183	1.414	1.257	0.348	0.960	0.807
EOU2_EasyLearning	6.091	4.889	5.550	1.044	1.364	1.317			
EOU3_Frustrating	3.545	4.556	4.000	1.572	1.236	1.487	**Case valid**		
EOU4_Controllable	5.182	4.222	4.750	0.874	1.481	1.251	**09**	**10**	**09-10**
EOU5_RigidInflexible	3.545	4.222	3.850	1.368	1.302	1.348	11/11	9/9	20/20
EOU6_EasyRemembering	5.273	4.778	5.050	1.421	0.972	1.234			
EOU7_MentalEffort	2.727	4.556	3.550	1.272	1.236	1.538			
EOU8_Understandable	5.455	5.000	5.250	0.688	1.225	0.967			
EOU9_EfforttoBecomeSkillful	3.273	4.000	3.600	1.849	1.658	1.759			
EOU10_OverallEaseofUse	5.455	4.778	5.150	1.128	1.202	1.182			
Scale Statistics	44.545	45.000	44.750	4.886	11.325	8.162			

Table 42 - Correlation Matrix for Perceived Ease of Use of Wiki

Correlation Matrix for Perceived Ease of Use of Wiki										
2009										
	EOU1	**EOU2**	**EOU3**	**EOU4**	**EOU5**	**EOU6**	**EOU7**	**EOU8**	**EOU9**	**EOU10**
EOU1	1.000									
EOU2	-0.162	1.000								
EOU3	0.806	0.028	1.000							
EOU4	-0.193	-0.020	-0.225	1.000						
EOU5	0.803	0.242	0.824	-0.426	1.000					
EOU6	-0.238	0.723	-0.028	0.117	0.173	1.000				
EOU7	-0.133	-0.506	-0.118	0.319	-0.423	-0.674	1.000			
EOU8	-0.369	0.772	-0.160	0.514	-0.077	0.679	-0.073	1.000		
EOU9	0.137	-0.221	0.116	0.090	-0.065	-0.678	0.843	-0.029	1.000	
EOU10	-0.524	0.640	-0.323	-0.092	-0.177	0.352	0.025	0.609	0.078	1.000
2010										
	EOU1	**EOU2**	**EOU3**	**EOU4**	**EOU5**	**EOU6**	**EOU7**	**EOU8**	**EOU9**	**EOU10**
EOU1	1.000									
EOU2	0.583	1.000								
EOU3	0.787	0.412	1.000							
EOU4	0.835	0.694	0.675	1.000						
EOU5	0.883	0.649	0.613	0.944	1.000					
EOU6	0.637	0.545	0.844	0.646	0.637	1.000				
EOU7	0.858	0.486	0.755	0.880	0.846	0.636	1.000			
EOU8	0.577	0.673	0.743	0.689	0.549	0.840	0.661	1.000		
EOU9	0.693	0.442	0.732	0.814	0.695	0.621	0.915	0.677	1.000	
EOU10	0.735	0.822	0.767	0.874	0.755	0.809	0.767	0.934	0.753	1.000

Correlation Matrix for Perceived Ease of Use of Wiki										
2009-2010										
	EOU1	**EOU2**	**EOU3**	**EOU4**	**EOU5**	**EOU6**	**EOU7**	**EOU8**	**EOU9**	**EOU10**
EOU1	1.000									
EOU2	0.223	1.000								
EOU3	0.732	0.000	1.000							
EOU4	0.402	0.535	0.057	1.000						
EOU5	0.808	0.256	0.761	0.195	1.000					
EOU6	0.102	0.630	0.143	0.383	0.258	1.000				
EOU7	0.272	-0.287	0.368	0.212	0.245	-0.292	1.000			
EOU8	0.217	0.713	0.183	0.664	0.192	0.695	0.115	1.000		
EOU9	0.381	-0.014	0.382	0.335	0.284	-0.281	0.805	0.279	1.000	
EOU10	0.106	0.756	0.000	0.525	0.147	0.536	0.097	0.795	0.283	1.000

Table 43 - Factor Analysis for Perceived Ease of Use of Wiki

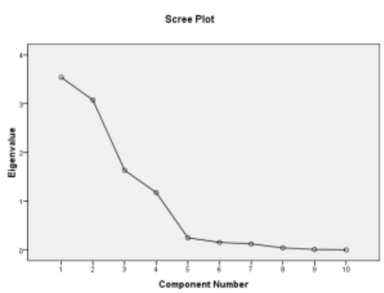
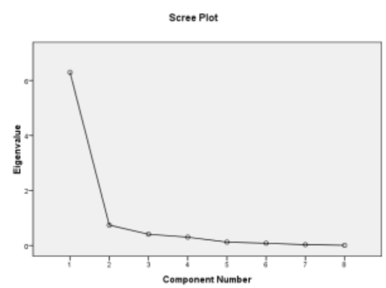
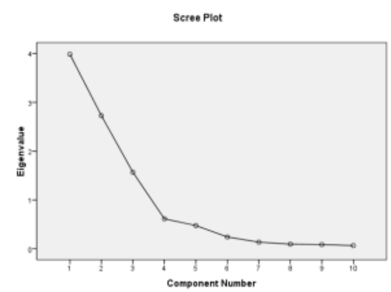
Factor Analysis	**2009**	**2010**	**09-10**
Correlation	Determinant = 7.76E-009	Not positive definite, remove EOU_EasyLearning and EOU_RigidInflexible Determinant = 1.65E-006	Determinant = 9.29E-005
KMO	.188	.742	.657
Bartlett's Test of Sphericity	Approx.Chi-Square=108.931, df=45, sig.=.000	Approx.Chi-Square= 59.904, df= 28, sig.=.000	Approx.Chi-Square=137.706, df=45, sig.=.000
Extration sums of Sqared Loadings(PCA)	Cumulative= 27.918, 55.414, 80.366, 94.232%	Cumulative= 78.676%	Cumulative= 35.384, 61.486, 82.787%
Component(PCA)	Four components	One component	Three components
Extration sums of Sqared Loadings(PAF)	Cumulative= 27.115, 54.023, 78.391, 91.889%	Cumulative= 75.699%	Cumulative= 32.882, 56.793, 76.297%
Factors(PAF)	Four factors	One factor	Three factors
Scree Plot			

Table 44 - Communalities for Perceived Ease of Use of Wiki

	Communalities (PCA)			Communalities (PAF)					
	2009	2010	09-10	2009		2010		09-10	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
EOU1	0.925	0.746	0.837	0.990	0.904	0.905	0.705	0.829	0.764
EOU2	0.923		0.825	0.999	0.900			0.825	0.776
EOU3	0.883	0.787	0.841	0.990	0.828	0.877	0.754	0.790	0.730
EOU4	0.977	0.821	0.636	0.996	0.972	0.960	0.801	0.709	0.490
EOU5	0.955		0.883	0.998	0.950			0.816	0.861
EOU6	0.934	0.719	0.783	0.993	0.907	0.838	0.671	0.820	0.671
EOU7	0.956	0.834	0.869	0.999	0.941	0.954	0.818	0.785	0.744
EOU8	0.990	0.744	0.876	0.999	0.999	0.969	0.702	0.870	0.882
EOU9	0.961	0.767	0.911	0.993	0.949	0.907	0.731	0.818	0.950
EOU10	0.921	0.877	0.818	0.932	0.840	0.984	0.875	0.783	0.762

Initial in PCA are 1s.

Table 45 – Component (Factor) Matrix for Perceived Ease of Use of Wiki

	Component Matrix (PCA)							
	2009*				**2010**	**2009-2010***		
	C1	**C2**	**C3**	**C4**	**C1**	**C1**	**C2**	**C3**
EOU1	0.913	-0.297	0.046	-0.035	0.864	0.158	0.881	0.189
EOU2	0.112	0.899	-0.321	-0.007		0.866	0.114	-0.247
EOU3	0.937	-0.041	0.044	-0.042	0.887	-0.014	0.897	0.189
EOU4	-0.191	0.042	0.107	0.963	0.906	0.734	0.117	0.289
EOU5	0.921	0.121	-0.183	-0.244		0.148	0.927	0.047
EOU6	0.009	0.599	-0.729	0.208	0.848	0.729	0.2	-0.461
EOU7	-0.207	-0.155	0.918	0.212	0.913	-0.038	0.199	0.91
EOU8	-0.095	0.853	-0.078	0.497	0.862	0.922	0.106	0.121
EOU9	0.119	0.048	0.971	0.02	0.876	0.158	0.226	0.913
EOU10	-0.345	0.85	0.135	-0.246	0.936	0.891	-0.039	0.15
	Factor Matrix (PAF)							
	2009*				**2010**	**2009-2010***		
	F1	**F2**	**F3**	**F4**	**F1**	**F1**	**F2**	**F3**
EOU1	0.902	-0.295	0.044	-0.032	0.839	0.16	0.838	0.187
EOU2	0.106	0.889	-0.314	-0.018		0.846	0.11	-0.221
EOU3	0.907	-0.046	0.039	-0.046	0.868	0.003	0.831	0.199
EOU4	-0.191	0.046	0.104	0.96	0.895	0.647	0.137	0.231
EOU5	0.92	0.119	-0.179	-0.24		0.153	0.914	0.053
EOU6	0.008	0.6	-0.715	0.191	0.819	0.697	0.174	-0.393
EOU7	-0.21	-0.159	0.91	0.209	0.904	-0.047	0.206	0.836
EOU8	-0.096	0.866	-0.072	0.484	0.838	0.925	0.099	0.133
EOU9	0.116	0.044	0.966	0.016	0.855	0.151	0.222	0.937
EOU10	-0.34	0.812	0.121	-0.226	0.935	0.86	-0.029	0.148

* Rotation Method: Varimax with Kaiser Normalization.

5.2.4 Intention to Use the Wiki

In the TAM model for Wiki, we created two questions to measure the intention to use Wiki in the future. We found the data had high reliability; items had very high correlations (>0.9) with each other, indicating there might be a collinearity problem. Data had low adequacy, so data for the items were too similar to each other. A one-factor solution was suggested, which also indicated items had high internal consistency.

The two items are “In the future, I will use a Wiki on software design projects whenever I can” and “I am highly likely to use a Wiki within the next year.” From Table 46 we can see the two items has the same means and similar std. deviations, which means generally students somewhat agrees they intend to use Wiki in the future. We have checked the raw data, and found that 75% of students provided exactly the same answers for the two questions. Almost all responses in 2009 provided high scores as answers, but there were four “neutral” and one low score in 2010, which made the mean lower than in 2009. The 20 valid cases provides a high reliability (α=.974). The correlation of the two items (0.95) are higher than 0.9, so collinearity of items could be a problem.

From Table 48 we conclude that the sampling adequacy of the pooled data is poor (KMO=.5), although Bartlett’s Test of Sphericity is significant (χ^2=40.593, p=.000). Communalities are high (see Table 49), which means the total explained variances of the two items are high. Both PCA and PAF suggest the two items have the same loadings on one latent factor.

Table 46 - Reliability Test for Intention to Use Wiki

	Item Statistics						Reliability		
	Mean			Std. Deviation			Cronbach's Alpha		
	09	10	0910	09	10	0910	09	10	0910
USE1_ WillUse	5.727	3.444	4.700	1.555	1.944	2.055	0.980	0.944	0.974
USE2_ LikelyUse	5.727	3.444	4.700	1.618	1.810	2.029			
							Case valid		
							09	10	0910
Scale Stat.	11.455	6.889	9.400	3.142	3.655	4.031	11/11	9/9	20/20

Table 47 - Correlation Matrix for Intention to Use Wiki

Correlation Matrix		
2009		
	USE1_WillUse	**USE2_LikelyUse**
USE1_WillUse	1.00	
USE2_LikelyUse	0.961	1.00
2010		
	USE1_WillUse	**USE2_LikelyUse**
USE1_WillUse	1.00	
USE2_LikelyUse	0.896	1.00
2009-2010		
	USE1_WillUse	**USE2_LikelyUse**
USE1_WillUse	1.00	
USE2_LikelyUse	0.95	1.00

Table 48 - Factor Analysis for Intention to Use Wiki

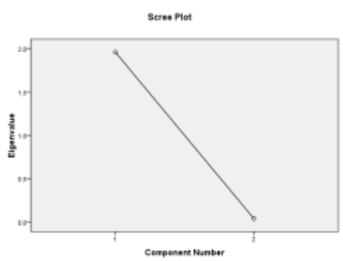
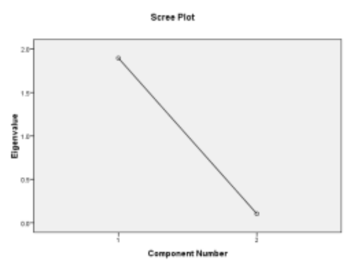
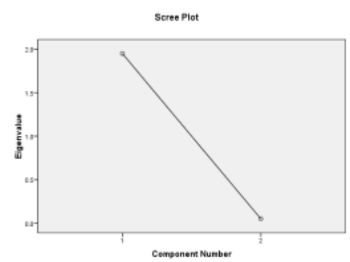
Factor Analysis	**2009**	**2010**	**09-10**
Correlation	Determinant = .076	Determinant = .197	Determinant = .098
KMO	.500	.500	.500
Bartlett's Test of Sphericity	Approx.Chi-Square=21.861, df=1, sig.=.000	Approx.Chi-Square=10.551, df=1, sig.=.001	Approx.Chi-Square=40.593, df=1, sig.=.000
Extration sums of Sqared Loadings(PCA)	Cumulative= 98.052%	Cumulative= 94.798%	Cumulative= 97.479%
Component(PCA)	One component	One component	One component
Extration sums of Sqared Loadings(PAF)	Cumulative= 96.046%	Cumulative= 89.523%	Cumulative= 94.882%
Factors(PAF)	One factor	One factor	One factor
Scree Plot			

Table 49 - Communalities for Intention to Use Wiki

	Communalities (PCA)			Communalities (PAF)					
	2009	2010	09-10	2009		2010		09-10	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
USE1	0.981	0.948	0.975	0.924	0.960	0.803	0.895	0.902	0.949
USE2	0.981	0.948	0.975	0.924	0.960	0.803	0.895	0.902	0.949

Initial in PCA are 1s.

Table 50 - Component (Factor) Matrix for Intention to Use Wiki

	Component Matrix (PCA)			Factor Matrix (PAF)		
	2009	2010	09-10	2009	2010	09-10
	C1	C1	C1	F1	F1	F1
USE1	0.99	0.974	0.987	0.98	0.946	0.974
USE2	0.99	0.974	0.987	0.98	0.946	0.974

5.2.5 Attitude toward using Tablet PC

Our result shows that pooled data has a high reliability; items have relative high correlations with others; data adequacy is good; one-factor solution is suggested after pooling the data and the variance of each item is well explained. Overall speaking, the result confirms the hypothesis for the one factor "Attitude" in the model.

By taking a look at the means of items (Table 51), we believe generally students had somewhat positive attitudes on using TPCs. The means are around 5, one level higher than "Neutral." Most of items have relative high standard deviations, ranging from 1.281 to 1.835, indicating that student perceptions varied considerably. The pooled data provides an excellent reliability (α=.956) with 20 valid responses. Correlations of items range from 0.681 to 0.961 (see Table 52), and 70% are higher than 0.8, indicating there might be a problem of multicollinearity. The result of the pooled data in Table 53 shows that sampling adequacy (KMO=0.777) is intermediate, and the Bartlett's Test of Sphericity is significant (χ^2=122.892, p=.000), so a factor analysis is appropriate to be performed.

Table 51 - Reliability Test for Attitude toward using Tablet PC

	Item Statistics						Reliability		
	Mean			Std. Deviation			Cronbach's Alpha		
	09	10	0910	09	10	0910	09	10	0910
ATT1	5.091	5.000	5.050	1.700	2.062	1.820	0.951	0.972	0.956
ATT2	5.273	4.333	4.850	1.104	2.236	1.725			
ATT3	5.182	4.778	5.000	1.662	2.108	1.835	**Case valid**		
ATT4	5.000	5.444	5.200	1.183	1.424	1.281	**09**	**10**	**09-10**
ATT5	5.000	5.444	5.200	1.612	1.590	1.576	11/11	9/9	20/20
Scale Stat.	25.545	25.000	25.300	6.743	9.055	7.651			

Table 52 - Correlation Matrix for Attitude toward using Tablet PC

Correlation Matrix

2009

	ATT1	ATT2	ATT3	ATT4	ATT5
ATT1	1.000				
ATT2	0.838	1.000			
ATT3	0.984	0.788	1.000		
ATT4	0.746	0.689	0.763	1.000	
ATT5	0.875	0.618	0.895	0.891	1.000

2010

	ATT1	ATT2	ATT3	ATT4	ATT5
ATT1	1.000				
ATT2	0.922	1.000			
ATT3	0.949	0.919	1.000		
ATT4	0.894	0.851	0.870	1.000	
ATT5	0.953	0.867	0.891	0.896	1.000

2009-2010

	ATT1	ATT2	ATT3	ATT4	ATT5
ATT1	1.000				
ATT2	0.841	1.000			
ATT3	0.961	0.848	1.000		
ATT4	0.808	0.681	0.783	1.000	
ATT5	0.895	0.650	0.855	0.891	1.000

Both PCA and PAF on the pooled data suggest that all the items have heavy loadings on the extracted single component or factor. The cumulated variances are higher than 80% both in PCA and PAF. The communalities range from 0.749 to 0.95 in PCA, and from 0.662 to 0.975 in PAF (Table 54). Both PCA and PAF suggest one latent component or factor is appropriate to be extracted, and all five items have major loadings on the factor (Table 55). Overall speaking, the result of factor analysis for the attitude toward using TPCs is what we expect to see, and we believe the items can explain the factor well.

Table 53 - Factor Analysis for Attitude toward using Tablet PC

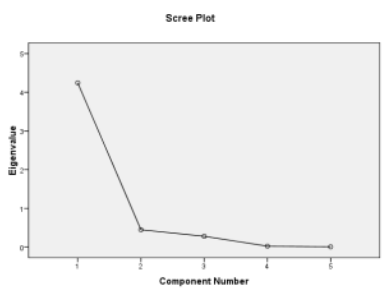
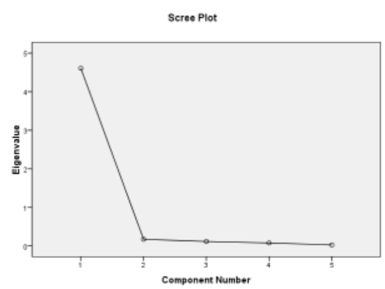
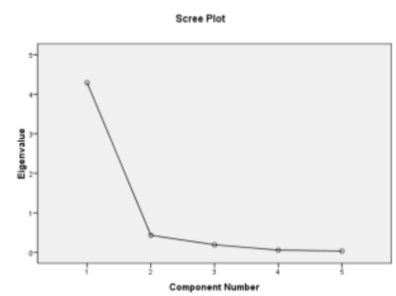
Factor Analysis	**2009**	**2010**	**09-10**
Correlation	Determinant = 8.25E-005	Determinant = .000	Determinant = .001
KMO	.592	.877	.777
Bartlett's Test of Sphericity	Approx.Chi-Square=70.518, df=10, sig.=.000	Approx.Chi-Square= 47.012, df= 10, sig.=.000	Approx.Chi-Square= 122.892 , df=10, sig.=.000
Extration sums of Sqared Loadings(PCA)	Cumulative= 84.895%	Cumulative= 92.119%	Cumulative= 85.861%
Component (PCA)	One component	One component	One component
Extration sums of Sqared Loadings(PAF)	Cumulative= 81.537%	Cumulative= 97.9%	Cumulative= 82.655%
Factors(PAF)	One factor	One factor	One factor
Scree Plot			

Table 54 - Communalities for Attitude toward using Tablet PC

	Communalities (PCA)			Communalities (PAF)					
	2009	2010	09-10	2009		2010		09-10	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
ATT1	0.936	0.968	0.950	0.988	0.955	0.961	0.979	0.954	0.975
ATT2	0.723	0.903	0.749	0.933	0.627	0.872	0.871	0.811	0.662
ATT3	0.932	0.931	0.925	0.977	0.948	0.917	0.917	0.930	0.931
ATT4	0.785	0.882	0.807	0.941	0.707	0.831	0.839	0.827	0.739
ATT5	0.870	0.922	0.862	0.973	0.840	0.923	0.903	0.919	0.825

* Initial in PCA are 1s.

Table 55 - Component (Factor) Matrix for Attitude toward using Tablet PC

	Component Matrix (PCA)			Factor Matrix (PAF)		
	2009	2010	09-10	2009	2010	09-10
	C1	C1	C1	F1	F1	F1
ATT1	0.967	0.984	0.974	0.977	0.990	0.988
ATT2	0.850	0.950	0.865	0.792	0.933	0.814
ATT3	0.965	0.965	0.962	0.974	0.958	0.965
ATT4	0.886	0.939	0.898	0.841	0.916	0.860
ATT5	0.933	0.960	0.929	0.916	0.950	0.909

5.2.6 Perceived Usefulness of Tablet PC

Perceived Usefulness represents the degree of a student's belief that using a TPC can help increase their performance. Results indicate the data is reliable, but item correlations are too high, and linear dependency could occur. Sampling adequacy is high for the pooled data, but lower for each single year, and one factor is extracted. All items have major loadings on the factor and explain the latent factor well.

We believe the means of items for the pooled data reflect that students have variety of opinions about whether Tablet PCs are useful or not in a project course, and the result shows that in general students agree TPCs are useful. It seems item standard deviations are higher than items in other factors, so it's better to know the portions of people agree and disagree about the usefulness of TPCs. As we can see from Table 56, a plurality of students selected agree answers (scores from 5 to 7) for the eight questions in the survey; a substantial minority of students have neutral opinions for the usefulness of TPCs (a score of 4 as an answer); and a slightly larger minority students choose disagree answers (scores from 1 to 3) for these questions. The pooled data provide a high reliability (α=.982) with 20 cases. Item correlations for the pooled data (see Table 57) range from 0.709 to 0.94, and only 7% are less than 0.8, suggesting item multicollinearity might be a problem.

From Table 58 we can conclude the pooled data has a good sampling adequacy (KMO=.868), and its Bartlett's Test of Sphericity is significant

(χ^2=238.173, p=.000). Evidences show that analysis result improves when the data size increases (e.g., KMO and χ^2 increase). These results suggest that although a factor analysis is appropriate, there could be linear dependency of the items (Determinant = 2.12E-007), and they may be solved with a larger sample size. Both PCA and PAF suggest a one-factor solution for the analysis. All the items have major loadings on the latent factor, ranging from 0.867 to 0.97 in PCA and 0.838 to 0.972 in PAF (see Table 60). Communalities for items (see Table 59) are relatively high except USEF1_QualityofWork (h^2=0.534 in PCA; h^2=0.462 in PAF). Similarly, factor loadings (see Table 40) of items are high except USEF1 (0.751 in PCA, and 0.702 in PAF). Overall speaking, it seems the factor Perceived Usefulness of Tablet PC is well represented by these eight items, but it may have multicollinearity and linear dependency problems, therefore a larger sample size would be preferred.

Table 56 - Reliability Test for Perceived Usefulness of Tablet PC

	Item Statistics									Reliability		
	0910			Mean			Std. Deviation			Cronbach’s Alpha		
	Agree	Neutral	Disagree	09	10	09-10	09	10	09-10	09	10	09-10
USEF1_QualityofWork	50%	30%	20%	4.36	4.67	4.50	1.50	2.00	1.70	0.974	0.989	0.982
USEF2_ControlOverWork	55%	20%	25%	4.46	4.44	4.45	1.86	2.40	2.06			
USEF3_WorkMoreQuickly	50%	20%	30%	4.09	4.22	4.15	2.12	2.54	2.25	**Case valid**		
USEF4_CriticalAspects	60%	5%	35%	4.73	4.89	4.80	2.01	2.32	2.09	**09**	**10**	**09-10**
USEF5_IncreaseProductivity	45%	30%	25%	4.36	4.33	4.35	1.86	2.45	2.08	11/11	9/9	20/20
USEF6_ImprovePerformance	50%	20%	30%	4.36	4.56	4.45	1.75	2.30	1.96			
USEF7_AllowsMoreWork	40%	30%	30%	4.00	4.11	4.05	1.79	2.32	1.99			
USEF8_OverallUsefulness	60%	10%	30%	4.82	4.44	4.65	1.94	2.46	2.13			
Scale Statistics				35.18	35.67	35.40	13.68	18.13	15.39			

Table 57 - Correlation Matrix for Perceived Usefulness of Tablet PC

Correlation Matrix

2009

	USEF1	USEF2	USEF3	USEF4	USEF5	USEF6	USEF7	USEF8
USEF1	1.000							
USEF2	0.650	1.000						
USEF3	0.680	0.951	1.000					
USEF4	0.668	0.786	0.830	1.000				
USEF5	0.665	0.958	0.930	0.727	1.000			
USEF6	0.669	0.957	0.935	0.802	0.940	1.000		
USEF7	0.484	0.900	0.844	0.809	0.872	0.928	1.000	
USEF8	0.643	0.883	0.880	0.937	0.852	0.906	0.893	1.000

2010

	USEF1	USEF2	USEF3	USEF4	USEF5	USEF6	USEF7	USEF8
USEF1	1.000							
USEF2	0.867	1.000						
USEF3	0.927	0.924	1.000					
USEF4	0.963	0.886	0.962	1.000				
USEF5	0.944	0.927	0.951	0.933	1.000			
USEF6	0.916	0.923	0.919	0.953	0.918	1.000		
USEF7	0.873	0.821	0.867	0.912	0.874	0.880	1.000	
USEF8	0.950	0.915	0.965	0.977	0.970	0.970	0.936	1.000

2009-2010

	USEF1	USEF2	USEF3	USEF4	USEF5	USEF6	USEF7	USEF8
USEF1	1.000							
USEF2	0.772	1.000						
USEF3	0.817	0.935	1.000					
USEF4	0.828	0.838	0.899	1.000				
USEF5	0.824	0.940	0.940	0.837	1.000			
USEF6	0.813	0.936	0.925	0.883	0.926	1.000		
USEF7	0.709	0.854	0.856	0.864	0.873	0.900	1.000	
USEF8	0.804	0.898	0.919	0.950	0.916	0.933	0.911	1.000

Table 58 - Factor Analysis for Perceived Usefulness of Tablet PC

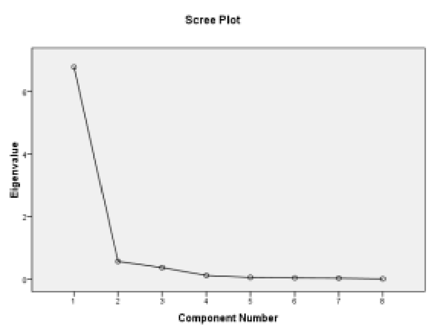
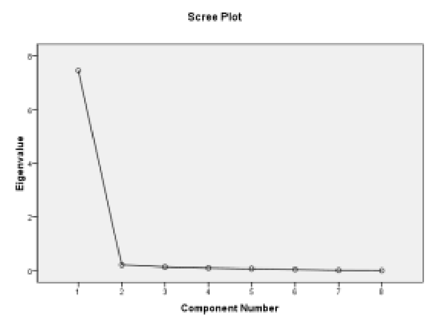
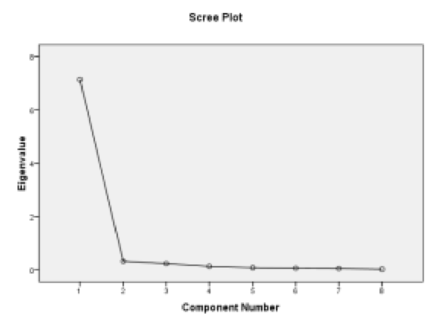
Factor Analysis	**2009**	**2010**	**09-10**
Correlation	Determinant = 1.35E-007	Determinant = 1.59E-012	Determinant = 2.12E-007
KMO	.737	.475	.868
Bartlett's Test of Sphericity	Approx.Chi-Square= 102.826, df=28, sig.=.000	Approx.Chi-Square= 122.257, df=28, sig.=.000	Approx.Chi-Square= 238.173, df=28, sig.=.000
Extration sums of Sqared Loadings(PCA)	Cumulative= 84.846%	Cumulative= 93.244%	Cumulative= 89.172 %
Component(PCA)	One component	One component	One component
Extration sums of Sqared Loadings(PAF)	Cumulative= 83.051%	Cumulative= 92.317%	Cumulative= 87.710%
Factors(PAF)	One factor	One factor	One factor
Scree Plot			

Table 59 - Communalities for Perceived Usefulness of Tablet PC

	Communalities (PCA)			Communalities (PAF)					
	2009	2010	09-10	2009		2010		09-10	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
USEF1	0.531	0.928	0.751	0.798	0.459	0.997	0.917	0.805	0.702
USEF2	0.936	0.884	0.904	0.957	0.940	1.000	0.860	0.926	0.892
USEF3	0.924	0.947	0.934	0.961	0.923	1.000	0.942	0.941	0.931
USEF4	0.793	0.965	0.883	0.962	0.751	0.998	0.966	0.951	0.864
USEF5	0.898	0.948	0.924	0.955	0.888	1.000	0.943	0.954	0.919
USEF6	0.948	0.938	0.940	0.972	0.957	1.000	0.930	0.934	0.939
USEF7	0.850	0.859	0.852	0.953	0.827	1.000	0.829	0.869	0.825
USEF8	0.908	0.990	0.944	0.962	0.901	1.000	1.000	0.963	0.945

Initial in PCA are 1s.

Table 60 - Component (Factor) Matrix for Perceived Usefulness of Tablet PC

	Component Matrix (PCA)			Factor Matrix (PAF)		
	2009 C1	2010 C1	09-10 C1	2009 F1	2010 F1	09-10 F1
USEF1	0.728	0.964	0.867	0.678	0.958	0.838
USEF2	0.967	0.940	0.951	0.969	0.927	0.945
USEF3	0.961	0.973	0.966	0.961	0.971	0.965
USEF4	0.890	0.982	0.940	0.866	0.983	0.930
USEF5	0.948	0.974	0.961	0.942	0.971	0.958
USEF6	0.974	0.968	0.970	0.978	0.964	0.969
USEF7	0.922	0.927	0.923	0.909	0.910	0.908
USEF8	0.953	0.995	0.972	0.949	1.000	0.972

5.2.7 Perceived Ease of Use of Tablet PC

Results for the Perceived Ease of Use items for Tablet PCs again do not match our expectations from the literature. Once again, we believe negative wording questions might be one of the problems, and another is the limited data size. Though the pooled data was reliable, its sampling adequacy was poor, suggesting factor analysis was inappropriate.

As we have discussed in the section 5.2.3, negative wording problem existed among the Ease of Use items for Wiki, and it also happened with items for TPC. From item means (see Table 61) we conclude that it seems students have "neutral" (a score of 4 in the answer") opinions about negative wording questions, but item standard deviations indicate their opinions vary a lot. It seems students strongly agree that it's easy to remember how to operate with TPCs, but it is not easy to become skillful, since it requires some efforts. An interesting thing to notice is that responses for the questions asking about needed efforts for using TPCs (EOU and EOU9) in 2009 (Mean=2.545 for both) is much lower than in 2010 (Mean=5.778 for EOU7, 5.556 for EOU9), indicating the students in 2010 found the TPCs required less effort. This opinion may be influenced by the maturity of TPC technologies, the education background, learning experience, etc. We believe if students perceive using TPCs are free of effort, it is more likely they will accept to use TPC.

The Ease of Use items analysis result are similar for Wiki and TPCs. Some students provide answers reflecting inconsistent opinions about using TPCs.

For example, a student answered all ease of use questions with a score of 5, and another answered almost all EOU questions with a score of 7. However, the pooled data with 20 valid responses still provides an intermediate reliability (α=0.734).

Taking a look at the correlations among items (see Table 62), 67% of the correlations are lower than 0.3, and some are negative. This indicates some items have weak or no relationships with others. From Table 63 we conclude factor analysis is not suggested, because the pooled data sampling adequacy is too low to be accepted (KMO=.406).

Table 61 - Reliability Test for Perceived Ease of Use of Tablet PC

	Item Statistics									Reliability		
	0910			Mean			Std. Deviation			Cronbach's Alpha		
	Agree	Neutral	Disagree	09	10	0910	09	10	0910	09	10	09-10
EOU1_Cumbersome	50%	10%	40%	3.55	4.78	4.10	1.97	1.79	1.94	0.255	0.84	0.734
EOU2_EasyLearning	100%	0%	0%	6.36	6.56	6.45	0.81	0.53	0.69			
EOU3_Frustrating	45%	15%	40%	3.82	4.56	4.15	2.32	2.01	2.16		**Case valid**	
EOU4_Controllable	60%	15%	25%	4.46	5.56	4.95	1.64	1.67	1.70	**09**	**10**	**09-10**
EOU5_RigidInflexible	50%	10%	40%	3.91	4.44	4.15	1.81	1.74	1.76	11/11	9/9	20/20
EOU6_EasyRemembering	90%	10%	0%	6.00	5.89	5.95	1.00	0.93	0.95			
EOU7_MentalEffort	45%	15%	40%	2.55	5.78	4.00	1.37	1.09	2.05			
EOU8_Understandable	85%	15%	0%	5.46	6.11	5.75	1.13	0.60	0.97			
EOU9_EfforttoBecomeSkillful	50%	0%	50%	2.55	5.56	3.90	1.81	1.24	2.17			
EOU10_OverallEaseofUse	80%	10%	10%	5.55	5.67	5.60	1.29	1.41	1.31			
Scale Statistics				44.18	54.89	49.00	5.69	8.95	8.98			

Table 62 - Correlation Matrix for Perceived Ease of Use of Tablet PC

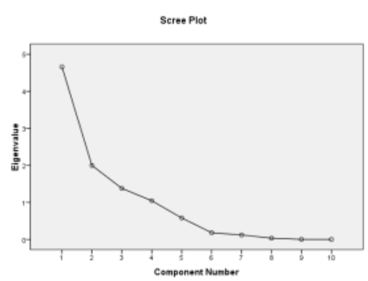
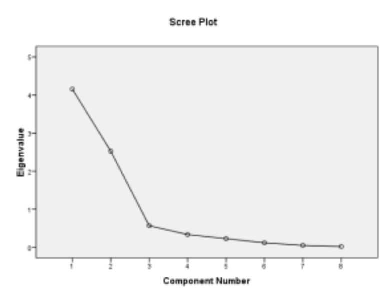
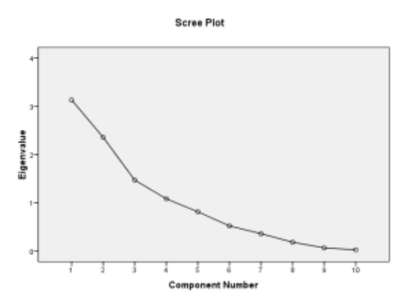
Correlation Matrix for Perceived Ease of Use of Tablet PC										
2009										
	EOU1	**EOU2**	**EOU3**	**EOU4**	**EOU5**	**EOU6**	**EOU7**	**EOU8**	**EOU9**	**EOU10**
EOU1	1.000									
EOU2	0.177	1.000								
EOU3	0.507	-0.228	1.000							
EOU4	-0.489	-0.137	-0.240	1.000						
EOU5	0.379	0.025	0.543	-0.288	1.000					
EOU6	-0.457	0.247	0.000	0.061	-0.220	1.000				
EOU7	0.324	-0.378	0.602	0.102	0.787	-0.512	1.000			
EOU8	-0.753	0.020	-0.463	0.148	-0.613	0.709	-0.695	1.000		
EOU9	0.049	-0.422	0.647	0.212	0.717	0.000	0.837	-0.379	1.000	
EOU10	-0.600	-0.209	-0.331	-0.034	-0.531	0.541	-0.580	0.910	-0.354	1.000
2010										
	EOU1	**EOU2**	**EOU3**	**EOU4**	**EOU5**	**EOU6**	**EOU7**	**EOU8**	**EOU9**	**EOU10**
EOU1	1.000									
EOU2	0.147	1.000								
EOU3	0.736	0.263	1.000							
EOU4	0.298	0.743	0.569	1.000						
EOU5	0.759	0.242	0.815	0.508	1.000					
EOU6	-0.243	0.398	-0.030	0.449	0.189	1.000				
EOU7	-0.348	0.458	0.006	0.282	0.058	0.589	1.000			
EOU8	0.724	0.570	0.772	0.680	0.664	0.249	0.233	1.000		
EOU9	-0.163	0.618	0.011	0.620	0.336	0.823	0.658	0.243	1.000	
EOU10	0.907	0.447	0.778	0.513	0.728	-0.222	-0.216	0.784	-0.024	1.000

Correlation Matrix for Perceived Ease of Use of Tablet PC

2009-2010

	EOU1	EOU2	EOU3	EOU4	EOU5	EOU6	EOU7	EOU8	EOU9	EOU10
EOU1	1.000									
EOU2	0.201	1.000								
EOU3	0.611	-0.048	1.000							
EOU4	-0.030	0.201	0.146	1.000						
EOU5	0.551	0.116	0.660	0.108	1.000					
EOU6	-0.370	0.280	-0.022	0.195	-0.059	1.000				
EOU7	0.303	0.037	0.368	0.362	0.424	-0.109	1.000			
EOU8	-0.182	0.179	-0.057	0.376	-0.163	0.504	0.027	1.000		
EOU9	0.214	-0.004	0.430	0.468	0.514	0.151	0.897	0.088	1.000	
EOU10	0.078	0.035	0.152	0.226	0.050	0.195	-0.215	0.787	-0.125	1.000

Table 63 - Factor Analysis for Perceived Ease of Use of Tablet PC[5]

Factor Analysis	**2009**	**2010**	**09-10**
Correlation	Determinant = 1.10E-009	Not positive definite, remove EOU5 and EOU7, then Determinant = 5.54E-005	Determinant = .000
KMO	.341	.646	.406
Bartlett's Test of Sphericity	Approx.Chi-Square=120.317, df=45, sig.=.000	Approx.Chi-Square= 44.101, df= 28, sig.= .027	Approx.Chi-Square=113.330, df=45, sig.=.000
Extration sums of Sqared Loadings(PCA)	Cumulative= 32.16, 61.921, 77.579, 90.838%	Cumulative= 46.933, 83.492%	Cumulative= 23.93, 36.994, 67.968, 80.412%
Component(PCA)	Four components	Two components	Four components
Extration sums of Sqared Loadings(PAF)	Cumulative= 46.544, 66.407, 80.104, 90.467%	Cumulative= 49.480, 78.396%	Cumulative= 28.984, 50.617, 63.309, 69.296%
Factors(PAF)	Four factors	Two factors	Four factors
Scree Plot			

[5] Factor Analysis is not suggested for 2009 and the pooled data.

Table 64 - Communalities for Perceived Ease of Use of Tablet PC[6]

	Communalities (PCA)*			Communalities (PAF)					
	2009	2010	09-10	2009		2010		09-10	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
EOU1	0.853	0.874	0.826	0.961	0.835	0.944	0.829	0.657	0.670
EOU2	0.964	0.699	0.929	0.996	0.961	0.862	0.583	0.492	0.111
EOU3	0.790	0.787	0.745	0.991	0.788	0.796	0.698	0.663	0.626
EOU4	0.896	0.833	0.572	0.977	0.880	0.800	0.790	0.469	0.331
EOU5	0.807		0.719	0.995	0.806			0.676	0.665
EOU6	0.942	0.790	0.593	0.999	0.944	0.870	0.664	0.810	0.774
EOU7	0.952		0.858	1.000	0.953			0.938	0.873
EOU8	0.972	0.872	0.906	0.997	0.972	0.890	0.846	0.923	0.934
EOU9	0.982	0.891	0.946	0.999	0.984	0.856	0.905	0.934	0.999
EOU10	0.925	0.934	0.948	0.996	0.925	0.965	0.957	0.902	0.946

Initial in PCA are 1s.

[6] Factor Analysis is not suggested for 2009 and the pooled data.

Table 65 - Component (Factor) Matrix for Perceived Ease of Use of TPC[7]

	Component Matrix (PCA)									
	2009*				2010*		09-10*			
	C1	**C2**	**C3**	**C4**	**C1**	**C2**	**C1**	**C2**	**C3**	**C4**
EOU1	0.21	-0.63	-0.62	0.19	0.92	-0.17	0.90	-0.02	-0.10	0.07
EOU2	-0.20	-0.01	-0.09	0.96	0.38	0.75	0.14	-0.02	0.02	0.95
EOU3	0.79	-0.07	-0.39	-0.11	0.88	0.09	0.80	0.27	0.12	-0.11
EOU4	0.00	0.00	0.95	-0.05	0.54	0.74	-0.04	0.63	0.38	0.18
EOU5	0.82	-0.29	-0.18	0.15			0.78	0.33	-0.05	0.08
EOU6	0.09	0.91	0.04	0.33	-0.20	0.87	-0.33	0.21	0.44	0.50
EOU7	0.79	-0.50	0.12	-0.26			0.28	0.87	-0.16	-0.04
EOU8	-0.42	0.88	0.16	-0.07	0.85	0.38	-0.16	0.15	0.91	0.16
EOU9	0.94	-0.04	0.23	-0.21	-0.08	0.94	0.25	0.94	-0.02	-0.01
EOU10	-0.39	0.81	-0.06	-0.34	0.97	0.02	0.19	-0.18	0.94	-0.06

	Factor Matrix (PAF)									
	2009*				2010*		09-10*			
	F1	**F2**	**F3**	**F4**	**F1**	**F2**	**F1**	**F2**	**F3**	**F4**
EOU1	0.21	-0.62	-0.61	0.18	0.90	-0.16	0.04	0.80	0.00	-0.17
EOU2	-0.20	-0.01	-0.09	0.96	0.36	0.67	0.02	0.09	0.07	0.31
EOU3	0.79	-0.07	-0.39	-0.11	0.83	0.10	0.22	0.76	0.06	0.07
EOU4	0.00	0.01	0.94	-0.05	0.52	0.72	0.47	0.01	0.28	0.18
EOU5	0.82	-0.29	-0.18	0.15			0.27	0.76	-0.08	0.12
EOU6	0.09	0.91	0.04	0.33	-0.17	0.80	0.09	-0.22	0.18	0.83
EOU7	0.79	-0.50	0.12	-0.26			0.88	0.27	-0.10	-0.12
EOU8	-0.42	0.88	0.16	-0.07	0.84	0.38	0.19	-0.21	0.86	0.34
EOU9	0.94	-0.04	0.23	-0.21	-0.07	0.95	0.95	0.28	-0.07	0.14
EOU10	-0.39	0.81	-0.06	-0.34	0.98	0.02	-0.14	0.15	0.95	0.09

* Rotation Method: Varimax with Kaiser Normalization.

[7] Factor Analysis is not suggested for 2009 and the pooled data.

5.2.8 Actual Use of Tablet PC

In the TAM model for Tablet PCs, nine questions are created in the research to measure the actual usage of TPCs. Each question has an answer of five choices. Result indicates that data has high reliability and intermediate sampling adequacy; but there could be a problem of linear dependency in the matrix. Factor analysis is not suggested for each single year, but it is appropriate after pooling the data. Result indicates there is a common factor exists among these nine items.

From Table 66 we can see 20 valid responses provide a high reliability (α=.952). In the pooled data 6 out of 9 items (USE1, USE2, and USE4 to USE7) have means higher than 3, indicating on average students use TPC for these tasks only a few times a week, but less than once a day. Three items (USE3, USE8, and USE9) have means between 2 to 3. This means students use TPC more than once a week but less than a few times per week for other course work and office software; furthermore, they don't want to pay much to buy TPCs.

Data from 2009 and 2010 showed that no student chose answer "(f) $400 - $500" and "(g) More than $500," so we consider it as a five-option question, and remove the last two options to make it consists with other EOU items. After modification the highest value in the choices is from $300 to $400. The average of the TPC usage is less than what we expect, because we believe as a computer engineering student, he or she should use computer at least once a day for the tasks specified in the course, either for coursework or for personal use. From the table we can see almost all the items have a standard deviation higher than 1.5

except the item that asks how much students willing to pay for a TPC (Use9). Students who rarely use TPCs provided by the instructor probably use their own PCs more regularly. We guess the reasons could be they are more familiar with their own PCs, or they think their PCs have better configurations than TPCs.

In Table 67 the correlations of the pooled data range from 0.281 (USE5 vs. USE9) to 0.977(USE1 vs. USE4). 22% correlations are higher than 0.8, indicating there might be some concern about multicollinearity. A small determinant (1.19E-006) shows that linear dependency of items may become to a problem (see Table 68). Sampling adequacy for the pooled data is intermediate (KMO=.788), and the Bartlett's Test of Sphericity is significant (χ^2=206.934, p=.000), which indicate the factor analysis is only appropriate for the pooled data. Both PCA and PAF suggest all items have major loadings on the latent factor, among which USEF9 has a lower score (0.554 in PCA, and 0.5 in PAF). The Extraction sums of Squared Loadings are only in an intermediate level (74.418% in PCA, 69.546% in PAF), which means the factor is not strong enough to catch all the information from all the items. Overall speaking, we can extract a common factor about the actual usage of Tablet PC from these items.

Table 66 - Reliability Test for Use of Tablet PC

	Answers for five levels of experience in ascending order					Item Statistics						Reliability		
	0910					Mean			Std. Deviation			Cronbach's Alpha		
	1	2	3	4	5	**09**	**10**	**0910**	**09**	**10**	**0910**	**09**	**10**	**0910**
USE1_UseforEmail	30%	5%	0%	15%	50%	3.82	3.11	3.50	1.83	1.83	1.82	0.955	0.961	0.952
USE2_UseforProj	35%	0%	5%	5%	55%	3.27	3.67	3.45	1.90	2.00	1.91			
USE3_UseforOther	40%	10%	15%	15%	20%	3.18	2.00	2.65	1.66	1.41	1.63	**Case valid**		
USE4_UseforInternet	30%	0%	10%	5%	55%	3.73	3.33	3.55	1.85	1.87	1.82	**9**	**10**	**09-10**
USE5_UseforUAResource	30%	0%	10%	15%	45%	3.82	3.00	3.45	1.83	1.66	1.76	11/11	9/9	20/20
USE6_UseforPersonal	35%	5%	5%	15%	40%	3.00	3.44	3.20	1.84	1.88	1.82			
USE7_UseforCollaborativeWork	40%	0%	5%	15%	40%	3.18	3.11	3.15	1.83	2.03	1.87			
USE8_UseforOfficeSW	35%	10%	15%	15%	25%	2.82	2.89	2.85	1.72	1.69	1.66			
USE9_WillingtoPay	45%	30%	5%	20%	0%	1.64	2.44	2.00	1.03	1.24	1.17			
Scale Statistics						28.46	27.00	27.80	13.44	13.78	13.25			

Table 67 - Correlation Matrix for Use of Tablet PC

Correlation Matrix

2009

	USE1	USE2	USE3	USE4	USE5	USE6	USE7	USE8	USE9
USE1	1.000								
USE2	0.732	1.000							
USE3	0.865	0.868	1.000						
USE4	0.987	0.677	0.864	1.000					
USE5	1.000	0.732	0.865	0.987	1.000				
USE6	0.680	0.741	0.881	0.645	0.680	1.000			
USE7	0.754	0.844	0.939	0.724	0.754	0.946	1.000		
USE8	0.622	0.597	0.677	0.548	0.622	0.882	0.772	1.000	
USE9	0.227	0.261	0.511	0.259	0.227	0.528	0.463	0.242	1.000

2010

	USE1	USE2	USE3	USE4	USE5	USE6	USE7	USE8	USE9
USE1	1.000								
USE2	0.864	1.000							
USE3	0.771	0.530	1.000						
USE4	0.972	0.935	0.709	1.000					
USE5	0.863	0.905	0.426	0.927	1.000				
USE6	0.928	0.976	0.659	0.984	0.923	1.000			
USE7	0.770	0.781	0.567	0.714	0.595	0.740	1.000		
USE8	0.649	0.690	0.732	0.724	0.535	0.765	0.478	1.000	
USE9	0.748	0.674	0.715	0.793	0.610	0.766	0.377	0.804	1.000

2009-2010

	USE1	USE2	USE3	USE4	USE5	USE6	USE7	USE8	USE9
USE1	1.000								
USE2	0.751	1.000							
USE3	0.824	0.629	1.000						
USE4	0.977	0.775	0.777	1.000					
USE5	0.944	0.752	0.717	0.953	1.000				
USE6	0.745	0.851	0.679	0.774	0.724	1.000			
USE7	0.749	0.807	0.725	0.716	0.665	0.839	1.000		
USE8	0.617	0.637	0.639	0.620	0.563	0.826	0.633	1.000	
USE9	0.371	0.472	0.386	0.445	0.281	0.641	0.385	0.487	1.000

Table 68 - Factor Analysis for Use of Tablet PC

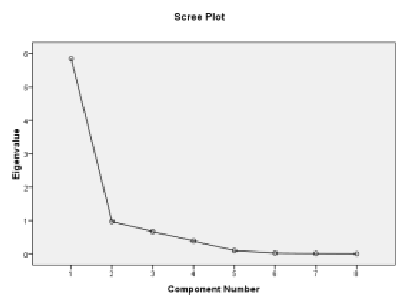
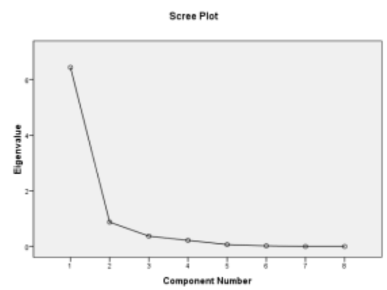
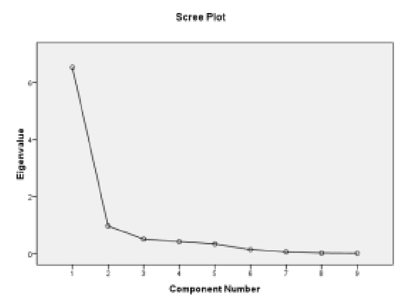
Factor Analysis	**2009**	**2010**	**09-10**
Correlation	Not positive definite, remove USE_UseforUAResource, Determinant = 8.55E-009	Not positive definite, Remove USE_UseforCollaborativeWork : Determinant = 1.06E-010	Determinant = 1.19E-006
KMO	.490	.556	.788
Bartlett's Test of Sphericity	Approx.Chi-Square= 120.751, df=28, sig.=.000	Approx.Chi-Square= 103.345, df=28, sig.=.000	Approx.Chi-Square= 206.934, df= 36, sig.=.000
Extration sums of Sqared Loadings(PCA)	Cumulative= 73.112%	Cumulative= 80.471%	Cumulative= 74.418%
Component(PCA)	One component	One component	One component
Extration sums of Sqared Loadings(PAF)	Cumulative= 70.364%	Cumulative= 78.341%	Cumulative= 69.546%
Factors(PAF)	One factor	One factor	One factor
Scree Plot			

Table 69 - Communalities for Use of Tablet PC

	Communalities (PCA)			Communalities (PAF)					
	2009	2010	09-10	2009		2010		09-10	
	Extraction	Extraction	Extraction	Initial	Extraction	Initial	Extraction	Initial	Extraction
USE1	0.779	0.891	0.862	0.999	0.739	0.989	0.887	0.976	0.863
USE2	0.740	0.821	0.775	0.992	0.694	0.993	0.793	0.796	0.745
USE3	0.959	0.643	0.709	0.999	0.993	0.873	0.566	0.757	0.665
USE4	0.733	0.949	0.871	0.999	0.683	0.999	0.975	0.977	0.875
USE5			0.780					0.956	0.757
USE6	0.865	0.938	0.855	0.984	0.852	0.999	0.957	0.950	0.844
USE7	0.917		0.743	0.984	0.930			0.878	0.706
USE8	0.636	0.711	0.615	0.960	0.569	0.929	0.644	0.782	0.555
USE9	0.220	0.752	0.307	0.936	0.170	0.867	0.695	0.740	0.250

* Initial in PCA are 1s.

Table 70 - Component (Factor) Matrix for Use of Tablet PC

	Component Matrix (PCA)			Factor Matrix (PAF)		
	2009	2010	09-10	2009	2010	09-10
	C1	C1	C1	F1	F1	F1
USE1	0.882	0.944	0.929	0.860	0.942	0.929
USE2	0.860	0.906	0.881	0.833	0.890	0.863
USE3	0.979	0.802	0.842	0.996	0.753	0.815
USE4	0.856	0.974	0.933	0.826	0.988	0.935
USE5			0.883			0.870
USE6	0.930	0.968	0.925	0.923	0.979	0.919
USE7	0.958		0.862	0.964		0.840
USE8	0.798	0.843	0.784	0.754	0.802	0.745
USE9	0.469	0.867	0.554	0.412	0.834	0.500

5.3 Summary of Analysis

In this chapter we have discussed the Exploratory Factor Analysis results for each factor in the CMPE 420 course blog survey model and Technology Acceptance Models for Wiki and Tablet PC. Based on the findings from the surveys, we believe the course CMPE 420 was successful in improving students' security self-efficacy. A few hypothesized factors in the three models were not supported by our factor analysis. However, the analysis is based on the limited data size, which means the results may be improved if the data size increases. As showed in Table 71 and Table 72, Attitude, Perceived Usefulness and Use in the TAM models for Wiki and Tablet PC can be explained well by their corresponding items, but Perceived Ease of Use items did not properly reflect the expected theoretical structure. We conclude that generally students have positive attitude when using Wiki and Tablet PC, and they somewhat agree both Wiki and Tablet PC are useful. Negative wording questions for Ease of Use detected a problem of students answering the questions without reading or thinking carefully, which is a severe problem for a small size dataset. From students' responses for Ease of Use positive wording questions we know they somewhat agree that Wiki and Tablet PC are easy to use. The answers for the Intention to Use Wiki questions reflect that students slightly agree they will use Wiki in future. From the answers for Actual Use of Tablet PC, it seems some students use Tablet PC a lot, but some students use it rarely. On average the actual usage of Table PC is lower than we expect. It seems students don't want to pay much for a Tablet PC, and no one wants to pay no more than $300. Overall speaking, the acceptance of using Table

PC is not fully successful; however, the acceptance of using Wiki is better and can be considered as successful.

The five-item instrument for computer security experience indicates a two-factor model fits the current data best. The factors can be explained as experience and trainings in “Networks” and “Websites & Software Systems.” Experience on designing and building networks directly reflects a student’s security knowledge and abilities to protect computers and systems over the networks. On the other hand, a student who works with websites and software systems may also experienced security problems. As showed in Table 71, generally students have some amount of experience in computer security, which is reasonable for being novice learners. Taking a look at the table, the major concern is the small data size, which may lead unstable results. We also found that the course Reliable and Secure Systems Design was successful in improving students’ security self-efficacy and achieving our teaching goals.

Table 71 - Summary of Course Blog Survey Model

Factor in the model	Items and Responses	Exploratory Factor Analysis	Latent Factors	Explanation
Computer Security Experience (EXP)	5 items (N=26)	Appropriate, data is reliable, sampling adequacy is acceptable	Two factors: "Networks" and "Websites & Software Systems."	Items for training cross loading on the two factors. On average students have some computer experience related to security but not much.
Motivating Tasks (MOT)	9 items (N=22)	Appropriate, data is reliable, sampling adequacy is acceptable, but concern about linear dependency problem	Two factors	Two factors overlap a lot. Small data size is a major problem. Generally students believe they can learn things they are interested by reading posts and discussion.
Autonomy Support (AUT)	5 items (N=22)	Appropriate, reliability is intermediate, sampling adequacy is acceptable	One factor	Cumulative explained variance is low. Small data size might be a problem. Generally students think their autonomy is supported by the instructor, but they expect to get more discussions about how to meet the goal of using the blog.
Mastery Evaluation(MAST)	10 items (N=21)	EFA is not suggested, data is not reliable, sampling adequacy is poor		Small data size problem exists.
Change in Security Self-Efficacy	9 items in initial survey, and 9 in final survey (N=22)	Appropriate, data is reliable, sampling adequacy is moderate	Three factors	Two factors overlap with each other. Data for some items are not normally distributed. Generally Students' Security Self-Efficacies improve significantly.

Table 72 - Summary of Technology Acceptance Models for Wiki and Tablet PC

	Factor	Items	Exploratory Factor Analysis	Latent Factors	Explanation
Wiki	Attitude (ATT)	Five (N=20)	Appropriate, data has high reliability, sampling adequacy is moderate	One factor	Generally students have some level of positive attitudes about using Wiki.
	Perceived Usefulness (USEF)	Eight (N=20)	Appropriate, data has high reliability, sampling adequacy is moderate	One factor	Generally students agree Wiki is useful in some degree.
	Perceived Ease of Use (EOU)	Ten (N=20)	Appropriate, data has high reliability, sampling adequacy is acceptable	Three factors	Factors are not overlapping. Negative wording question detected problems exists in data. From positive wording questions we believe students agree Wiki is somewhat easy to use.
	Intention to Use (USE)	Two (N=20)	Appropriate, data has high reliability, but sampling adequacy is low, and correlation is too high	One factor	Students slightly agree they will use Wiki in future.
Tablet PC	Attitude (ATT)	Five (N=20)	Appropriate, data has high reliability, sampling adequacy is moderate	One factor	Generally students have some level of positive attitudes about using TPC.
	Perceived Usefulness (USEF)	Eight (N=20)	Appropriate, data has high reliability, sampling adequacy is good	One factor	Generally students slightly agree TPC is useful.
	Perceived Ease of Use (EOU)	Ten (N=20)	EFA is not suggested. Data is reliable, but sampling adequacy is poor		Negative wording question detected problems exists in data. From positive wording questions we believe students agree TPC is easy to use in some degree.
	Actual Use of TPCs (USE)	Nine (N=20)	Appropriate, data has high reliability, sampling adequacy is moderate	One factor	Generally students didn't use TPC as much as we expected, and they don't want to pay much for TPC over a laptop.

Chapter 6: Correlation Analysis

Having determined that many (although not all) of the factors in our model are properly represented by their items, we next consider relationships among the factors. When dealing with multi-factor path models such as ours, one normally employs structural equation modeling for this task; however, our sample sizes are simply too small for those methods to work. Instead, we conduct a pairwise correlation analysis between those antecedent factors that we validated in the survey, and our outcome variables (Change in Security Self-Efficacy; Use of the Wiki, Use of the Tablet PC).

Correlation specifies the strength of the relationship between pairs of variables. A lot of analysts use the Pearson correlation when the variables are close to being normally distributed, but in this research the non-parametric Spearman's rho is preferred, as many of our variables are not normally distributed. Spearman's rho tests the linear and non linear relationships between variables. We tried both Pearson and Spearman's rho and found that most of the correlation coefficients computed by Spearman's rho were greater than the Pearson coefficients, which meant there were some non-linear relationships that the Pearson coefficients didn't capture. The detailed results are showing in the next two sections.

Correlation scores range between -1 and +1. Positive coefficients means there is a direct relationship, when one variable increases, the other also increases.

Generally speaking, a score greater than 0.8 indicates a strong relationship; 0.5 to 0.8 means moderate; 0.2 to 0.5 is moderate to weak; and below 0.2 indicate a little or no relationship [152]. After the number of factors is determined, factor scores can be calculated in SPSS, and be used in subsequent correlation analysis. We use the "Regression" method in SPSS to calculate the factor scores.

6.1 Factor Correlations in CMPE 420 Model

Table 73 shows Spearman's rho for each pair of variables. Examining the table, we can see there are three significant relationships in the table, while two significant relationships meet our expectation, Change_1 vs. EXP_1 and Change_2 vs. AUT_1. Change_1 vs. EXP_1 (r=-0.550, p=0.008) is a moderate negative relationship, and Change_2 vs. AUT_1 (r=0.469, p=0.028) is a weak positive relationship. The correlation between MOT_1 and AUT_1 (r=0.555, p=0.007) is significant; however, it is not our major interest. As we have discussed, EXP_1 can be interpreted as experience and training with websites and software; Change_1 represents security self-efficacy with computers and new technologies. Their negative correlation indicates the more experience students have before they take the course, the less change they perceive. This is no surprise, as the course is primarily aimed at novices in this field; more experienced students probably would not find the class makes a huge difference in their perceptions. On the other hand, a student without any pervious knowledge and experience about security will hopefully gain a considerable amount of knowledge and skill, which we would expect to be reflected in a change in self-efficacy. Change_2 is represents students' security self-efficacy in their physical and social environment. AUT_1 captures how students think their autonomy is supported by the instructor, in a way of offering choices, encouraging learning responsibilities, and regulating themselves when using the blog. There does not seem to be an obvious causal link between these two factors, beyond the basic fact that improved autonomy support leads to improved learning outcomes.

Table 73 - Spearman's rho Correlations Analysis (N=22)

			Change_1	Change_2	Change_3	EXP_1	EXP_2	MOT_1	MOT_2	AUT_1
Spearman's rho	Change_1	Correlation Coefficient	1	0.076	0.328	-.550**	-0.324	0.305	0.094	0.213
		Sig. (2-tailed)	.	0.736	0.136	0.008	0.141	0.167	0.676	0.341
	Change_2	Correlation Coefficient		1	-0.058	-0.108	-0.228	0.401	0.333	.469*
		Sig. (2-tailed)		.	0.797	0.631	0.308	0.064	0.13	0.028
	Change_3	Correlation Coefficient			1	-0.083	-0.259	-0.113	0.215	-0.255
		Sig. (2-tailed)			.	0.713	0.245	0.615	0.336	0.252
	EXP_1	Correlation Coefficient				1	0.043	-0.289	0.018	-0.347
		Sig. (2-tailed)				.	0.851	0.193	0.937	0.113
	EXP_2	Correlation Coefficient					1	-0.366	-0.122	-0.126
		Sig. (2-tailed)					.	0.094	0.588	0.576
	MOT_1	Correlation Coefficient						1	-0.067	.555**
		Sig. (2-tailed)						.	0.766	.007
	MOT_2	Correlation Coefficient							1	-.094
		Sig. (2-tailed)							.	.676
	AUT_1	Correlation Coefficient								1
		Sig. (2-tailed)								

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

6.2 Factor Correlations in CMPE 440 Model

Table 74 shows the Spearman's rho test for the factor Use with Attitude and Perceived Usefulness of Wiki. As we can see from the table, USE has positive and moderate correlations with ATT (r=0.642, p=0.002) and USEF (r=0.596, p= 0.006) at a significant level. This is what we expect to see from the analysis, because if students have better attitude towards using Wiki or he/she can perceived a better outcome of using Wiki, he/she will accept to use Wiki or even start to use Wiki frequently. ATT also has a moderate correlation with USEF(r=0.778, p=0.000). These findings are partially consistent with Davis's study of TAM. As he indicated in [8], he found both USEF and ATT had direct and positive influence on USE, and USEF also had direct influence on ATT.

Table 74 - Correlation Analysis for Wiki

Wiki Correlations					
			ATT	**USEF**	**USE**
Spearman's rho	**ATT**	Correlation Coefficient	1		
		Sig. (2-tailed)	.		
	USEF	Correlation Coefficient	.778**	1	
		Sig. (2-tailed)	.000	.	
	USE	Correlation Coefficient	.642**	.596**	1
		Sig. (2-tailed)	0.002	0.006	.

**. Correlation is significant at the 0.01 level (2-tailed).
N = 20

Table 75 shows the Spearman's rho test for the factor USE with ATT and USEF of Tablet PC. Similar to Wiki, USE of TPC has a positive and moderate correlation with USEF (r=0.596, p= 0.006), and USEF is strongly correlated with ATT (r=0.836, p= 0.000). The correlation between ATT and USE is not significant (r=0.409, p=0.073).

Table 75 - Correlation Analysis for Tablet PC

Tablet PC Correlations					
			ATT	USEF	USE
Spearman's rho	ATT	Correlation Coefficient	1		
		Sig. (2-tailed)	.		
	USEF	Correlation Coefficient	.836**	1	
		Sig. (2-tailed)	.000	.	
	USE	Correlation Coefficient	0.409	.679**	1
		Sig. (2-tailed)	0.073	0.001	.
**. Correlation is significant at the 0.01 level (2-tailed). N = 20					

6.3 General Discussion

In the model of CMPE 420 surveys, we expect to see the two factors of computer security experience which reflect students' developing experience and trainings in "Networks" and "Websites & Software Systems" have correlations with Motivating Tasks, Autonomy Support, and Change in Self-Efficacy. However, we only found two significant correlations: one is a factor of prior experience with website and software vs. a factor of the change of self-efficacy with computer systems and new technologies; the other is Autonomy Support vs. a factor of the change of self-efficacy with environment. Motivating Tasks is a single factor in Greene et al.'s model [132], but we cannot extract it as a one common factor in this research. A possible reason is that the data size is too small, and probably the structure of the data is not stable enough. The result may be changed as the data size increase. We have shown students' self-efficacy has significant improvement after they take CMPE 420, but we don't know exactly whether the blog is an essential reason of the improvement or not. However, the course blog is the only component in the class that was intended to directly affect student's security self-efficacy, so it's reasonable that we attribute this success at least partially to the course blog.

The correlation analysis of the factors in TAM for Wiki and Tablet PCs shows that the result has some level of consistency with Davis' TAM model. It shows that Ease of Use items in our survey are not reliable in factor analysis and not suitable for correlation analysis. In TAM of Wiki, there are significant positive correlations between any two factors among Attitude of using Wiki, Usefulness and intention to Use Wiki. In TAM of Tablet PC, there are two significant positive correlations which are Attitude vs. Usefulness, and Usefulness vs. actual Use of TPCs, but there is no evidence to support attitude influence actual use of TPCs directly and strongly. This may because of the limited data size.

Chapter 7: Summary and Future Work

In this research we have developed and applied measurement scales to determine the impact of three technological interventions in 4^{th}-year software engineering classes, which were a course blog, Wikis and Tablet PCs. In CMPE 420, we sought to measure the impact of a course blog on critical thinking about the security of built systems (the "security mindset"). Our conceptual framework is built on Social Cognitive Theory. We have introduced new scales for *Computer Experience* and *Security Self-Efficacy*, and combined these with existing scales for *Motivating Tasks*, *Autonomy Support* and *Mastery Evaluation* to form our surveys, which are administered in a pretest-posttest design. Despite a small sample size (partially offset by pooling the results of two replications of the survey in consecutive years), the two new scales appear to be psychometrically valid, the correlations between outcome and most antecedent factors appear to follow expected patterns, and the survey results do indicate that a significant improvement in Security Self-Efficacy took place over the course of the semester.

In CMPE 440, we sought to measure the perceived value of Wikis and Tablet PCs as enabling tools in a capstone design project. The conceptual model for this survey was the well-known TAM model from technology adoption theory. While scales for the mediating factors *Usefulness*, *Ease of Use*, and *Attitude* could be directly adapted from the literature on TAM (in particular the original TAM model in [8]), scales for the dependent variable *Use* had to be constructed from other sources. Sample size effects meant that we could only test the correlations between Attitude, Usefulness and Use;

however, these three were strongly correlated, as expected. In the end, students slightly favored the Wikis, and did not really favor the Tablet PCs.

Future work on this topic will principally revolve around the CMPE 420 survey. The problem of measuring computer experience in 4^{th}-year computer engineering students is common to every university having such a degree program. We believe that our approach (asking students to report their extracurricular activities that are relevant to the class) is a generally-applicable technique; we intend to test this hypothesis in other classes, both at the University of Alberta and elsewhere. In addition, this is a critically important question for employers in the IT sector, and we intend to examine the utility of our instruments for evaluating new employees in the industry. Likewise, the question of security self-efficacy is highly important to companies with any significant IT presence; today this ranges from the traditionally IT-heavy industries such as banking to those with less experience in IT management (health-care, process control, etc.) These industries need to train their employees in effective security procedures, and to evaluate the effect of this training. Our construct of security self-efficacy can potentially play an important role in such training efforts, and we intend to evaluate this possibility. Finally, we should note that the tablet-PC market has been revolutionized in the recent years by the launch of the iPad and its competitors. While the students in CMPE 440 did not seem impressed by the convertible Tablet PCs in our inventory, one wonders if they would be more receptive to, and find greater utility in, the new slate form factor. We will be considering the task-technology fit for these slates in the CMPE 440 context; and will seek to deploy and evaluate them in contexts where they are most likely to benefit the students.

References

[1] D. L. Goodhue and R. L. Thompson, "Task-technology fit and individual performance," *MIS Quarterly,* vol. 19, pp. 213-236, 1995.

[2] (2011, July 27). *Knowledge Infrastructure Program*. Available: http://www.ic.gc.ca/eic/site/696.nsf/eng/home

[3] J. Zhang*, et al.*, "Evaluating the Utility of Tablet PCs in a Software Engineering Capstone Course," presented at the Canadian Engineering Education Association Inaugural conference 2010, 2010.

[4] B. Smith*, et al.*, "A review of construct of computer experience," *Computers in Human Behavior,* vol. 15, pp. 227-242, 1999.

[5] D. Potosky and P. Bobko, "The Computer Understanding and Experience Scale: a self-report measure of computer experience," *Computers in Human Behavior,* vol. 14, pp. 337-348, May 25th 1998.

[6] T. Jones and V. A. Clarke, "Diversity as a determinant of attitudes: a possible explanation of the apparent advantage of single-sex settings," *Journal of Educational Computing Research,* vol. 12, pp. 51-64, 1995.

[7] M. Fishbein and I. Ajzen, *Belief, attitude, intention, and behavior : an introduction to theory and research*: Reading, Mass. : Addison-Wesley Pub. Co., 1975.

[8] F. D. Davis, "User acceptance of information systems : the technology acceptance model (TAM)," University of Michigan. School of Business Administration. Division of Research1987.

[9] M. M. Weil*, et al.*, "The Etiology of Computerphobia," *Computers in Human Behaviour,* vol. 6, pp. 361-379, 1990.

[10] J. Winfred Arthur, "Computer Attitudes, Computer Experience, and Their Correlates: An Investigation of Path Linkages," *Teaching of Psychology,* vol. 18, pp. 51-54, 1991.

[11] N. Bozionelos, "Computer Anxiety: relationship with computer experience and prevalence," *Computers in Human Behavior,* vol. 17, pp. 213-224, 2001.

[12] D. Potosky, "A field study of computer efficacy beliefs as an outcome of training: the role of computer playfulness, computer knowledge, and performance during training," *Computers in Human Behavior,* vol. 18, pp. 241-255, 2002.

[13] J. J. Beckers and H. G. Schmidt, "Computer experience and computer anxiety," *Computers in Human Behavior,* vol. 19, pp. 785-797, 2003.

[14] J. Todman and E. Monaghan, "Qualitative differences in computer experience, computer anxiety,and students' use of computers: a path model," *Computers in Human Behaviour,* vol. 10, pp. 529-539, 1994.

[15] F. Yaghmaie, "Development of a scale for measuring user computer eperience," *Journal of research in Nursing,* vol. 12, pp. 185-190, 2007.

[16] D. J. Ballou and B. R. Huguenard, "The Impact of Students' Perceived Computer Experience on Behavior and Performance in an Introductory Information Systems Course," *Journal of Information Systems Education,* vol. 19, pp. 87-97, 2008.

[17] M. Haverila, "Prior E-learning Experience and Perceived Learning Outcomes in an Undergraduate E-learning Course," *MERLOT Journal of Online Learning and Teaching,* vol. 7, pp. 206-218, June 2011.

[18] M.-P. Chen, "The Effects of Prior Computer Experience and Gender on High School Students' Learning of Computer Science Concepts from Instructional Simulations," presented at the 2010 10th IEEE International Conference on Advanced Learning Technologies, 2010.

[19] A. Bandura, *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice Hall, 1986.

[20] J. Leutzinger and I. Newmen, "Using social cognitive theory as a framework for designing medical self-care interventions," *AWHP'S WORKSITE HEALTH*, pp. 44-47, 1995.

[21] F. Pajares. (2002, July 01). *Overview of social cognitive theory and of self-efficacy*. Available: http://www.emory.edu/EDUCATION/mfp/eff.html

[22] B. Law and C. Hall, "Observational learning use and self-efficacy beliefs in adult sport novices," *Psychology of Sport and Exercise,* vol. 10, pp. 263-270, 2009.

[23] M. Y.Yi and F. D. Davis, "Developing and Validating an Observational Learning Model of Computer Software Training and Skill Acquisition," *Information Systems Research,* vol. 14, 2003.

[24] K. A. Orvis*, et al.*, "The Influence of Trainee Gaming Experience and Computer Self-Efficacy on Learner Outcomes of Videogame-Based Learning Environments," United States Army Research Institute for the Behavioral And Social Sciences, Technical Report 1164June 2005.

[25] M. v. Dinther*, et al.*, "Factors affecting students' self-efficacy in higher education," *Educational Research Review*, vol. 6, pp. 95-108, 2011.

[26] M. Pampaka*, et al.*, "Measuring mathematics self-efficacy as a learning outcome," *Research in Mathematics Education*, vol. 13, pp. 169-190, 2011.

[27] B. Shannon*, et al.*, "Self-efficacy: a contributor to the explanation of eating behavior," *HEALTH EDUCATION RESEARCH Theory & Practice*, vol. 5, pp. 395-407, 1990.

[28] D. C. Moos and R. Azevedo, "Learning With Computer-Based Learning Environments: A Literature Review of Computer Self-Efficacy," *Review of Educational Research*, vol. 79, pp. 576-600, 2009.

[29] D. R. Compeau and C. A. Higgins, "Computer Self-efficacy: Development of a Measure and Initial Test," *MIS Quarterly,* vol. 19, pp. 189-211, 1995.

[30] A. W. Harrison and K. Ranier, "The influence of individual differences on skill in end-user computing," *Journal of Management Information Systems Research*, vol. 9, pp. 93-111, 1992.

[31] E. Doyle, *et al.*, "Computer Anxiety, Self-Efficacy, Computer Experience: An investigation throughout a Computer Science degree," presented at the 35th ASEE/IEEE Frontiers in Education Conference, Indianapolis, IN, 2005.

[32] T. Hill, *et al.*, "Role of self-efficacy expectations in predicting the decision to use advanced technologies: The case of computers," *Journal of Applied Psychology*, vol. 72, pp. 307-313, 1987.

[33] B. Hasan, "The influence of specific computer experiences on computer self-efficacy beliefs," *Computers in Human Behavior*, vol. 19, pp. 443-450, 2003.

[34] R. Karsten, and Roberta M. Roth, "Computer Self-Efficacy: A Practical Indicator of Student Computer Competency in Introductory IS Courses," *Informing Science*, vol. 1, pp. 61-68, 1998.

[35] A. Bandura, "Organizational Application of Social Cognitive Theory," *Australian Journal of Management*, vol. 13, pp. 275-302, 1988.

[36] B. J. Zimmerman, "Self-Efficacy: An Essential Motive to Learn," *Contemporary Educational Psychology*, vol. 25, pp. 82-91, 2000.

[37] D. Compeau, *et al.*, "Social Cognitive Theory and Individual Reactions to Computing Technology: A Longitudinal Study," *MIS Quarterly*, vol. 23, pp. 145-158, June 1999.

[38] B. H. Loyd and C. Gressard, "Reliability and Factorial Validity of Computer Attitude Scales," *Educational and Psychological Measurement*, pp. 501-505, 1984.

[39] R. K. Heinssen, *et al.*, "Assessing Computer Anxiety: Development and Validation of the Computer Anxiety Rating Scale," *Computers and Human Behavior* vol. 3, pp. 49-59, 1987.

[40] J. J. Martocchio and T. A. Judge, "Relationship between conscientiousness and learning in employee training: mediating influences of self-deception and self-efficacy," *The Journal of applied psychology,* vol. 82, pp. 764-73, 1997.

[41] G. M. Marakas*, et al.*, "The Multilevel and Multifaceted Character of Computer Self-Efficacy: Toward Clarification of the Construct and an Integrative Framework for Research," *Information Systems Research,* vol. 9, pp. 126-163, 1998.

[42] R. Karsten and D. Schmidt, "Business Student Computer Self-Efficacy: Ten Years Later," *Journal of Information Systems Education,* vol. 19, pp. 445-453, 2008.

[43] B. Hasan, "Delineating the effects of general and system-specific computer self-efficacy beliefs on IS acceptance," *Information & Management,* vol. 43, pp. 565-571, 2006.

[44] L. Li, "A Critical Review of Technology Acceptance Literature," in *Southwest Decision Sciences Institute Conference*, Grambling, LA, 2010.

[45] V. Venkatesh and F. D. Davis, "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies," *Management Science,* vol. 46, pp. 186-204, 2000.

[46] I. Ajzen, "The Theory of Planned Behavior," *Organizational Behavior and Human Decision Processes*, vol. 50, pp. 179-211, 1991.

[47] S. Taylor and P. A. Todd, "Assessing IT Usage: The Role of Prior Experience," *MIS Quarterly*, vol. 19, pp. 561-570, 1995.

[48] V. Venkatesh*, et al.*, "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly,* vol. 27, pp. 425-78, 2003.

[49] B. H. Sheppard*, et al.*, "The Theory of Reasoned Action: A Meta-Analysis of Past Research with Recommendations for Modifications and Future Research," *Journal of Consumer Research,* vol. 15, pp. 325-343, 1988.

[50] J. K. Liker and A. A. Sindi, "User acceptance of expert systems: a test of the theory of reasoned action," *Journal of ENGINEERING AND TECHNOLOGY Management*, vol. 14, pp. 147-173, 1997.

[51] I. Ajzen, "Perceived Behavioral Control, Self-Efficacy, Locus of Control, and the Theory of Planned Behavior," *Journal of Applied Social Psychology,* vol. 32, pp. 665-683, 2002.

[52] I. Ajzen. (2006, July 27). *TPB Diagram*. Available: http://people.umass.edu/aizen/tpb.diag.html

[53] M. Rezaei, *et al.*, "Predicting e-learning application in agricultural higher education using technology acceptance model," *Turkish Online Journal of Distance Education,* vol. 9, pp. 85-95, 2008

[54] S. Y. Park, "An Analysis of the Technology Acceptance Model in Understanding University Students' Behavioral Intention to Use e-Learning," *Educational Technology & Society,* vol. 12, pp. 150-162, 2009.

[55] E. W. T. Ngai, *et al.*, "Empirical examination of the adoption of WebCT using TAM," *Computers & Education,* vol. 48, pp. 250-267, 2007.

[56] S. Elwood, *et al.*, "Investigating students' perceptions on laptop initiative in higher education," *Campus-Wide Information Systems,* vol. 23, pp. 336-349, 2006.

[57] N. Park, *et al.*, "University Instructors' Acceptance of Electronic Courseware: An Application of the Technology Acceptance Model," *Journal of Computer-Mediated Communication,* vol. 13, pp. 163-186, 2008.

[58] T. Teo, "Explaining the Intention to Use Technology Among Volitional Users in Education," *Int'l J of Instructional Media,* vol. 37, pp. 379-89, 2010.

[59] F. D. Davis, "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly,* vol. 13, pp. 319-340 September 1989.

[60] B. H. Wixom and P. A. Todd, "A Theoretical Integration of User Satisfaction and Technology Acceptance," *Information Systems Research,* vol. 16, pp. 85-102, 2005.

[61] V. Venkatesh, "Determinants of Perceived Ease of Use: Integrating Perceived Behavioral Control, Computer Anxiety and Enjoyment into the Technology Acceptance Model," *Information Systems Research,* vol. 11, pp. 342-365, 2000.

[62] S. Taylor and P. A. Todd, "Understanding Information Technology Usage: A Test of Competing Models," *Information Systems Research,* vol. 6, pp. 144-176, 1995.

[63] F. D. Davis*, et al.*, "Extrinsic and intrinsic motivation to use computers in the workplace," *J. Applied Social Psychology,* vol. 22, pp. 1111-1132, 1992.

[64] E. M. Rogers, *Diffusion of Innovations*, 5 ed. New York, NY: Free Press, 2003.

[65] G. C. Moore and I. Benbasat, "Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation," *Information Systems Research,* vol. 2, pp. 192-222, 1991.

[66] R. L. Thompson*, et al.*, "Personal Computing: Toward a Conceptual Model of Utilization," *MIS Quarterly,* vol. 15, pp. 125-143, 1991.

[67] H. Triandis, C., "Values, Attitudes, and Interpersonal Behavior," *Nebraska Symposium on Motivation,* vol. 27, pp. 195-259, 1980.

[68] V. Venkatesh, Morris, M., Davis, G.B., and Davis, F.D., "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly,* vol. 27, pp. 425-78, 2003.

[69] A. M. Kaplan and M. Haenlein, "Users of the world, unite! The challenges and opportunities of Social Media," *Business Horizons,* vol. 53, pp. 59-68, 2010.

[70] D. Rosen and C. Nelson, "Web 2.0: A New Generation of Learners and Education," *Computers in the Schools,* vol. 25, pp. 211-225, 2008.

[71] S. Minocha, "Role of social software tools in education: a literature review," *Education + Training,* vol. 51, pp. 353-369, 2009.

[72] T. Franklin and M. v. Harmelen, "Web 2.0 for Content for Learning and Teaching in Higher Education," Joint Information Systems Committee, London2007.

[73] B. Alexander, "Web 2.0: A new wave of innovation for teaching and learning," *EDUCAUSE Review*, vol. 41, pp. 33-44, 2006.

[74] S. Wunsch-Vincent and G. Vickery, "Directorate For Science, Technology and Industry Committee for Information, Computer and Communications Policy " Organisation for Economic Co-operation and Development April 12 2007.

[75] M. Blankenship, "How Social Media Can and Should Impact Higher Education," *Education Digest: Essential Readings Condensed for Quick Review,* vol. 76, pp. 39-42, 2011.

[76] A. Fernando. (2008, March-April) Baby steps in Web 2.0 education. *Communication World*.

[77] U. D. Ehlers, "Web 2.0 - e-learning 2.0 - quality 2.0? Quality for new learning cultures," *Quality Assurance in Education,* vol. 17, pp. 296-314, 2009.

[78] B. Collis and J. Moonen, "Web 2.0 tools and processes in higher education: quality perspectives," *Educational Media International,* vol. 45, pp. 93-106, 2008.

[79] P. R. Albion, "Web 2.0 in Teacher Education:Two Imperatives for Action," *Computers in the Schools,* vol. 25, 2008.

[80] N. B. Dohn, "Web 2.0: Inherent tensions and evident challenges for education," *Computer-Supported Collaborative Learning,* vol. 4, pp. 343-363, 2009.

[81] J. W. S. Sim and K. F. Hew, "The use of weblogs in higher education settings: A review of empirical research," *Educational Research Review,* vol. 5, pp. 151-163, 2010.

[82] D. Sifry. (2004, June 6th). *State of the blogosphere*. Available: http://www.sifry.com/alerts/archives/2004/10/state_of_the_blogosphere_october_2004.html

[83] D. Sifry. (November 6, 2006, June 6th). *State of the blogosphere*. Available: http://www.sifry.com/alerts/2006/11/state-of-the-blogosphere-october-2006/

[84] D. Sifry. (April 17, 2006, June 6th). *State of the blogosphere*. Available: http://www.sifry.com/alerts/2006/04/state-of-the-blogosphere-april-2006-part-1-on-blogosphere-growth/

[85] D. Churchill, "Web 2.0 in education: a study of the explorative use of blogs with a postgraduate class," *Innovations in Education and Teaching International,* vol. 48, pp. 149-158, 2011.

[86] X. Zeng and S. T. Harris, "Blogging in an Online Health Information Technology Class," *Perspectives in health information management / AHIMA, American Health Information Management Association,* vol. 2, 2005.

[87] M. Andergassen*, et al.*, "Weblogs in Higher Education-why do Students (not) blog?," *Electronic Journal of e-Learning,* vol. 7, pp. 203 -215, 2009.

[88] H.-T. Hou*, et al.*, "Using blogs as a professional development tool for teachers: analysis of interaction behavioral patterns," *Interactive Learning Environments,* vol. 17, pp. 325-340, December 2009.

[89] S.-H. Yang, "Using Blogs to Enhance Critical Reflection and Community of Practice," *Educational Technology & Society,* vol. 12, pp. 11-21, 2009.

[90] J. J. Jung, "Knowledge distribution via shared context between blog-based knowledge management systems: A case study of collaborative tagging," *Expert Systems with Applications,* vol. 36, pp. 10627-10633, 2009.

[91] M. Andergassen, Reinhold Behringer, Janet Finlay, Andrea Gorra and David Moore, "Weblogs in Higher Education- why do Students (not) blog?," *Electronic Journal of e-Learning,* vol. 7, pp. 203 -215, 2009.

[92] J. Lave and E. Wenger, *Situated learning: legitimate peripheral participation*. New York: Cambridge University Press, 1991.

[93] E. Wenger. (June, 2006, Sept. 20). *Communities of practice : a brief introduction*. Available: http://www.ewenger.com/theory/

[94] E. Wenger, *et al.*, "Cultivating communities of practice: a guide to managing knowledge," *ACADEMY OF MANAGEMENT LEARNING AND EDUCATION,* vol. 8, pp. 301-302, 2009.

[95] K. R. Parker and J. T. Chao, "Wiki as a Teaching Tool," *Interdisciplinary Journal of Knowledge and Learning Objects,* vol. 3, pp. 57-72, 2007.

[96] E. Tonkin. (2005 September 9). *Making the Case for a Wiki*. Available: http://www.ariadne.ac.uk/issue42/tonkin/

[97] H. Meishar-Tal and P. Gorsky, "Wikis: what students do and do not do when writing collaboratively," *Open Learning,* vol. 25, pp. 25-35, February 2010.

[98] S. Minocha and P. G. Thomas, "Collaborative Learning in a Wiki Environment: Experiences from a software engineering course," *New Review of Hypermedia and Multimedia,* vol. 13, pp. 187-209, 2007.

[99] H. L. Chen, *et al.*, "Using Wikis and Weblogs to Support Reflective Learning in an Introductory Engineering Design Course," presented at the Proceeding of the 2005 American Society for Engineering Education Annual Conference & Exposition, 2005.

[100] P. Duffy and A. Bruns, "The use of blogs, wikis and RSS in education: A conversation of possibilities," in *Proceedings of the Online Learning and Teaching Conference*, Brisbane, 2006.

[101] S. Minocha, *et al.*, "Using Wikis to Simulate Distributed Requirements Development in a Software Engineering Course," *Int. J. Engng Ed.,* vol. 24, pp. 689-704, 2008.

[102] E. Ras and J. Rech, "Using Wikis to support the Net Generation in improving knowledge acquisition in capstone projects," *The Journal of Systems and Software,* vol. 82, pp. 553-562, 2009.

[103] D. G. Neal and K. Davidson, "Contesting ideas of innovative teaching practice with tablet PCs," presented at the AARE 2008 Conference Brisbane, 2008.

[104] T. L. Derting and J. R. Cox, "Using a Tablet PC To Enhance Student Engagement and Learning in an Introductory Organic Chemistry Course," *Journal of Chemical Education*, vol. 85, pp. 1638-1643, 2008.

[105] (September 12). *7 Things you should know about Tablet PC's*. Available: http://www.ferris.edu/tac/docs/seventhings-tabletpc%20final.pdf

[106] (Jan 18, 2011, July 01). *Apple Reports First Quarter Results*. Available: http://www.apple.com/pr/library/2011/01/18Apple-Reports-First-Quarter-Results.html

[107] (April 20, 2011). *Apple Reports Second Quarter Results*. Available: http://www.apple.com/pr/library/2011/04/20Apple-Reports-Second-Quarter-Results.html

[108] (July 19, 2011, July 01). *Apple Reports Third Quarter Results*. Available: http://www.apple.com/pr/library/2010/07/20Apple-Reports-Third-Quarter-Results.html

[109] (October 18, 2011, July 01). *Apple Reports Fourth Quarter Results*. Available: http://www.apple.com/pr/library/2010/10/18Apple-Reports-Fourth-Quarter-Results.html

[110] s. smith. (September 12). *Make you know more about tablet PC - iPad, windows tablet PC, Android tablet PC*. Available: http://www.articlemonkeys.com/Make-you-know-more-about-tablet-PC-iPad-windows-tablet-PC-Android-tablet-PC-304764.html

[111] J. Frolik and J. B. Zurn, "Evaluation of Tablet PCs for engineering content development and instruction," in *American Society for Engineering Education Annual Conference & Exposition*, 2004.

[112] J. L. Hieb and P. A. S. Ralston, "Tablet PCs in Engineering Mathematics Courses at the J.B. Speed School of Engineering," *International Journal of Mathematical Education in Science and Technology*, vol. 41, pp. 487-500, 2010.

[113] C. Yoon and J. Sneddon, "Student perceptions of effective use of tablet PC recorded lectures in undergraduate mathematics courses," *International Journal of Mathematical Education in Science & Technology*, vol. 42, pp. 425-445, 2011.

[114] J. W. Rogers and J. R. Cox, "Integrating a Single Tablet PC in Chemistry, Engineering, and Physics Courses," *Joumal of College Science Teaching*, vol. 37, pp. 34-39, January/February 2008.

[115] J. Griffioen, *et al.*, "Teaching in realtime wireless classrooms," presented at the FIE '98. 28th Annual Frontiers in Education Conference, 1998.

[116] A. Chidanandan, *et al.*, "Evaluating the symbiosis of DyKnow software and pen-based computing in the Rose-Hulman classroom," in *Proceedings of WIPTE*, e. a. J. Prey, Ed., ed: Purdue Univ. Press, 2007, pp. 21-31.

[117] R. M. Cicchino and D. S. Mirliss, "learning and teaching," 2004.

[118] A. G. Enriquez, "Using Tablet PCs to Enhance Student Performance in an Introductory Circuits Course," in *American Society for Engineering Education Pacific Southwest Regional Conference*, 2009.

[119] S. G. Bilén, *et al.*, "Tablet PC Use and Impact on Learning in Thechnology and Engineering Classrooms: A Preliminary Study," The Pennsylvania State University.

[120] H. T. Nguyen, *et al.*, "Adopting tablet PCs in design education: student use of tablet PCs and lessons learned," in *Proc. World Conf. E-Learning in Corp., Govern., Health, and Higher Ed.*, ed, 2007, pp. 1172-1177.

[121] B. Kurtz, *et al.*, "Using podcasts and tablet PCs in computer science," in *45th annual southeast regional conference* 2007.

[122] K. Koile and D. Singer, "Development of a Tablet-PC-based System to Increase Instructor-Student Classroom Interactions and Student Learning," in *The Impact of Pen-based Technology on Education: Vignettes, Evaluations, and Future Directions*, D. Berque, *et al.*, Eds., ed: Purdue University Press., 2006, pp. 115-122.

[123] M. Moran, *et al.*, "Tablet personal computer integration in higher education: Applying the unified theory of acceptance and use technology model to understand supporting factors," *J. EDUCATIONAL COMPUTING RESEARCH*, vol. 42, pp. 79-101, 2010.

[124] O. El-Gayar and M. Moran, "Examing Students' Acceptance of Tablet PC Using TAM," *Issues in Information Systems,* vol. VIII, pp. 167-172, 2007.

[125] J. Cromack, "Technology and learning-centered education: Research-based support for how the tablet PC embodies the Seven Principles of Good Practice in Undergraduate Education," presented at the Frontiers in Education Conference, Saratoga Springs, NY 2008.

[126] Y. Arar. (2002, September 12). *Tablet PC: A Sneak Peek*. Available: http://www.pcworld.com/article/102215/tablet_pc_a_sneak_peek.html

[127] J. L. Popyack*, et al.*, "Pen-Based Electronic Grading of Online Student Submissions," Drexel University, Philadelphia2002.

[128] B. S. Bloom*, et al.*, *Taxonomy of educational objectives: the classification of educational goals*. Longmans, Green: Cognitive Domain New York, 1956.

[129] P. A. Kirschner*, et al.*, "Why minimal guidance during instruction does not work: an analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching," *Educational Psychologist,* vol. 41, pp. 75-86, 2006.

[130] (2011, November 1). *Qualities of a Good Question*. Available: http://www.statpac.com/surveys/question-qualities.htm

[131] M. a. Pett*, et al.*, *Making sense of factor analysis: the use of factor analysis for instrument development in health care research*. Thousand Oaks, London, New Delhi: Sage Publcations, 2003.

[132] B. A. Greene*, et al.*, "Predicting High School Students' Cognitive Engagement and Achievement: Contributions of Classroom Perceptions and Motivation," *Contemporary Educational Psychology,* vol. 29, pp. 462-482 2004.

[133] M. Huggard and C. M. Goldrick, "Computer Experience-Enhancing Engineering Education," presented at the 9th International Conference on Engineering Education, 2006.

[134] S. Dehaene, *et al.*, "Log or linear? Distinct intuitions of the number scale in Western and Amazonian indigene cultures," *Science,* vol. 320 pp. 1217-1220, May 2008.

[135] R. Agarwal and E. Karahanna, "On the Multi-dimensional Nature of Compatibility Beliefs in Technology Acceptance," presented at the Diffusion Interest Group in Information Technology, Tallahassee, FL, 1998.

[136] F. Prescod and L. Dong, "Learning Style Trends and Laptop Use Patterns: Implication for Students in an IT Business School," presented at the Proc ISECON, Dallas, TX, USA, 2006.

[137] J. Micklewright, "On Earnings-Related Unemployment Benefits and Their Relation to Earnings," *The Economic Journal,* vol. 95, pp. 133-145, 1985.

[138] J. F. Ermisch and R. E. Wright, "Welfare Benefits and Lone Parents' Employment in Great BritainAuthor," *The Journal of Human Resources,* vol. 26, pp. 424-456, 1991.

[139] I. Walker, "The Effects of Income Support Measures on the Labour Market Behaviour of Lone Mothers," *Fiscal Studies,* vol. 11, pp. 55-75, 1990.

[140] J. DeCoster. (Auguest 1, 1998). *Overview of Factor Analysis*. Available: http://www.stat-help.com/notes.html

[141] R. K. Henson and J. K. Roberts, "Use of Exploratory Factor Analysis in Published Research: Common Errors and Some Comment on Improved Practice," *Educational and Psychological Measurement,* vol. 66, pp. 393-416, June 2006.

[142] B. Thompson, *Exploratory and Confirmatory Factor Analysis: Understanding Concepts and Applicaitons*, First ed. Washington, DC: Amreican Psychological Association, 2004.

[143] A. B. Costello and J. W. Osborne, "Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis," *Practical Assessment Research & Evaluation,* vol. 10, 2005.

[144] L. R. Fabrigar, *et al.*, "Evaluating the use of exploratory factor analysis in psychological research," *Psychological Methods,* vol. 4, pp. 272-299, 1999.

[145] (November 15). *Exploratory Factor Analysis Theory and Application*. Available: http://www.let.rug.nl/nerbonne/teach/rema-stats-meth-seminar/Factor-Analysis-Kootstra-04.PDF

[146] A. Field, *Discovering Statistics using SPSS* 3ed. London: Sage Publication, 2009.

[147] (November 01). *SPSS FAQ-What does Cronbach's alpha mean?* Available: http://www.ats.ucla.edu/stat/spss/faq/alpha.html

[148] A. Yu. (November 11). *Using SAS for Item Analysis and Test Construction*. Available: http://www.creative-wisdom.com/teaching/assessment/alpha.html

[149] (November 11). *Testing for Normality using SPSS*. Available: http://statistics.laerd.com/spss-tutorials/testing-for-normality-using-spss-statistics.php

[150] C. R. Mehta and N. R. Patel, *SPSS Exact Tests™ 7.0 for Windows®.* . Chicago: SPSS Inc, 1996.

[151] G. D. Garson. (2008, March 27). *Significance Tests for Two Dependent Samples: McNemar, Marginal Homogeneity, Sign, and Wilcoxon Tests*. Available: http://faculty.chass.ncsu.edu/garson/PA765/mcnemar.htm

[152] N. A. Ismail, *et al.*, "Bone age is the best predictor of growth response to recombinant human growth hormone in Turner's syndrome," *Indian J Hum Genet* vol. 16, pp. 119-126, 2010.

Appendix 1: CMPE 420 Initial Survey

ID Code:_________________

For Questions 1-5, please circle the response that best corresponds to your level of experience.

1. What is the largest computer network (including both computers and switching devices such as routers) you have been responsible for designing or administering, at home or professionally?

a) One computer and an access point (modem, etc.)
b) 1-5 nodes connecting to an access point
c) Less than ten nodes, partitioned into subnets, connecting to one access point.
d) More than ten nodes connecting to an access point
e) More than ten nodes, partitioned into subnets, connecting to one or more access points

2. How many hours of computer-security training have you had (from a professional instructor or at work)?

a) Less than one hour
b) 1-2 hours
c) 3-8 hours
d) 9-40 hours
e) more than 40 hours

3. What is the most complex website you have ever had primary responsibility for designing?

a) A simple page using static HTML
b) An informational page with some dynamic elements
c) A simple interactive page, possibly connecting to a database
d) A web application with a two- or three-layer architecture
e) A fully functional live e-commerce site.

4. How many hours of security training (OTHER than computer security) have you had from a professional instructor or at work?

a) Less than one hour
b) 1-2 hours
c) 3-8 hours
d) 9-40 hours
e) more than 40 hours

5. What is the most complex software system you have had lead responsibility for designing and implementing in a professional setting?

a) No professional experience
b) Less than 500 lines of code
c) 500 – 1000 lines of code
d) 1000 – 10000 lines of code
e) More than 10000 lines of code

For questions 6-14, please circle the number that corresponds to your opinion.

The format of the answers is the following:

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

Questions:

6. I am confident that I can determine what security vulnerabilities are present in a computer system.

7. I am confident that I can suggest methods to control the vulnerabilities in a computer system.

8. I am confident that I can decide on the best way of improving security in a computer system.

9. I am confident that I can determine what security vulnerabilities are present in my physical or social environment.

10. I am confident that I can suggest methods to control the vulnerabilities in my physical or social environment.

11. I am confident that I can decide on the best way of improving security in my physical or social environment.

12. I am confident that I can determine what security vulnerabilities are associated with new technologies.

13. I am confident that I can suggest methods to control the vulnerabilities associated with new technologies.

14. I am confident that I can decide on the best way of improving security associated with new technologies.

Appendix 2: CMPE 420 Final Survey

ID Code:__________________

The format of the answers is the following:

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

Questions:

1. The blogging assignments in this class are interesting.

2. The instructor's blog posts emphasize gaining understanding of the class material.

3. The instructor shows how the blogging assignments are related to student's everyday lives or future careers.

4. The blogging assignments allow students to learn about things they are interested in.

5. This instructor helps us to understand how the blogging assignments will be useful to us.

6. The instructor's blog posts explain ideas in ways that make the information meaningful to students.

7. Students learn from the blog mainly by reading the instructor's blog posts. **R**

8. Students learn from the blog by participating in discussions.

9. The instructor values creative thinking and original ideas.

10. Using the blog, the instructor wants us to take responsibility for our own learning.

11. Students get to choose the topics they want to discuss on the blog.

12. The instructor discusses how we can plan to meet our goals using the blog.

13. Students are given a chance to correct their mistakes on the blog.

14. The instructor provides suggestions and guidance for organizing and managing the blogging assignments.

15. Only a few students can get high grades on the blog. **R**

16. The instructor uses more than one way to determine grades on the blog.

17. The blogging assignments were relevant to the exam on security.

18. Students have to compete against one another to get high grades on the blog. **R**

19. The grades for blogging assignments are distributed in a way that keeps them private.

20. When students make mistakes on the blog they are treated with respect.

21. Students can redo work to improve their grades in this class.

22. The instructor grades the blog fairly.

23. The instructor pays attention to whether I am improving.

24. Students are provided with guidelines for how they will be graded on blogging assignments.

25. Only students with the highest grades can keep up with the discussions on the blog. **R**

26. I am confident that I can determine what security vulnerabilities are present in a computer system.

27. I am confident that I can suggest methods to control the vulnerabilities in a computer system.

28. I am confident that I can decide on the best way of improving security in a computer system.

29. I am confident that I can determine what security vulnerabilities are present in my physical or social environment.

30. I am confident that I can suggest methods to control the vulnerabilities in my physical or social environment.

31. I am confident that I can decide on the best way of improving security in my physical or social environment.

32. I am confident that I can determine what security vulnerabilities are associated with new technologies.

33. I am confident that I can suggest methods to control the vulnerabilities associated with new technologies.

34. I am confident that I can decide on the best way of improving security associated with new technologies.

Appendix 3: CMPE 440 Survey

1. All things considered, using the Wiki in CMPE 440 is:

Good	___ ___ ___ ___ ___ ___ ___ Neutral	Bad
Wise	___ ___ ___ ___ ___ ___ ___ Neutral	Foolish
Favorable	___ ___ ___ ___ ___ ___ ___ Neutral	Unfavorable
Beneficial	___ ___ ___ ___ ___ ___ ___ Neutral	Harmful
Positive	___ ___ ___ ___ ___ ___ ___ Neutral	Negative

2. All things considered, using the Tablet PC in CMPE 440 is:

Good	___ ___ ___ ___ ___ ___ ___ Neutral	Bad
Wise	___ ___ ___ ___ ___ ___ ___ Neutral	Foolish
Favorable	___ ___ ___ ___ ___ ___ ___ Neutral	Unfavorable
Beneficial	___ ___ ___ ___ ___ ___ ___ Neutral	Harmful
Positive	___ ___ ___ ___ ___ ___ ___ Neutral	Negative

For the following questions, please circle the number corresponding to your opinion.

The format of the answers is the following:

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

Questions:

3. Using the Wiki improves the quality of my work.

4. Using the Wiki gives me greater control over my work.

5. The Wiki enables me to accomplish tasks more quickly.

6. The Wiki supports critical aspects of my schoolwork.

7. Using the Wiki increases my productivity.

8. Using the Wiki improves my performance on the project.

9. Using the Wiki allows me to accomplish more work than would otherwise be possible.

10. Overall, I find the Wiki useful in my schoolwork.

11. Using the Tablet PC improves the quality of my work.

12. Using the Tablet PC gives me greater control over my work.

13. The Tablet PC enables me to accomplish tasks more quickly.

14. The Tablet PC supports critical aspects of my schoolwork.

15. Using the Tablet PC increases my productivity.

16. Using the Tablet PC improves my performance on the project.

17. Using the Tablet PC allows me to accomplish more work than would otherwise be possible.

18. Overall, I find the Tablet PC useful in my schoolwork.

19. I find the Wiki cumbersome to use. **R**

20. Learning to operate the Wiki is easy for me.

21. Interacting with the Wiki is often frustrating. **R**

22. I find it easy to get the Wiki to do what I want it to do.

23. The Wiki is rigid and inflexible to interact with. **R**

24. It is easy for me to remember how to perform tasks using the Wiki.

25. Interacting with the Wiki requires a lot of mental effort. **R**

26. My interaction with the Wiki is clear and understandable.

27. I find it takes a lot of effort to become skillful at using the Wiki. **R**

28. Overall, I find the Wiki easy to use.

29. I find the Tablet PC cumbersome to use. **R**

30. Learning to operate the Tablet PC is easy for me.

31. Interacting with the Tablet PC is often frustrating. **R**

32. I find it easy to get the Tablet PC to do what I want it to do.

33. The Tablet PC is rigid and inflexible to interact with. **R**

34. It is easy for me to remember how to perform tasks using the Tablet PC.

35. Interacting with the Tablet PC requires a lot of mental effort. **R**

36. My interaction with the Tablet PC is clear and understandable.

37. I find it takes a lot of effort to become skillful at using the Tablet PC. **R**

38. Overall, I find the Tablet PC easy to use.

For the following questions, please circle the response that best represents your opinion

39. How often do you use the Tablet PC to check email?

a) Rarely
b) About once a week
c) A few times per week
d) About once a day
e) Multiple times per day

40. How often do you use the Tablet PC to work on your CMPE 440 projects?

a) Rarely
b) About once a week
c) A few times per week
d) About once a day
e) Multiple times per day

41. How often do you use the Tablet PC for any other coursework?

a) Rarely
b) About once a week
c) A few times per week
d) About once a day
e) Multiple times per day

42. How often do you use the Tablet PC to access the Internet for coursework?

a) Rarely

b) About once a week

c) A few times per week

d) About once a day

e) Multiple times per day

43. How often do you use the Tablet PC to access University of Alberta Internet resources?

a) Rarely
b) About once a week
c) A few times per week
d) About once a day
e) Multiple times per day

For the following questions, please circle the response that best represents your opinion

44. How often do you use the Tablet PC to access the Internet for personal use?

a) Rarely

b) About once a week

c) A few times per week

d) About once a day

e) Multiple times per day

45. How often do you use the Tablet PC for collaborative work, in or out of class?

a) Rarely

b) About once a week

c) A few times per week

d) About once a day

e) Multiple times per day

46. How often do you use the Tablet PC's word processing /spreadsheet / presentation software?

a) Rarely

b) About once a week

c) A few times per week

d) About once a day

e) Multiple times per day

47. How much more would you be willing to pay for a Tablet PC over a standard laptop?

a) Would not purchase

b) $0 - $100

c) $100 - $200

d) $200 - $300

e) $300 - $400

f) $400 - $500

g) More than $500

For the following questions, please circle the number corresponding to your opinion.

The format of the answers is the following:

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

48. In the future, I will use a Wiki on software design projects whenever I can.

49. I am highly likely to use a Wiki within the next year