# Technology and Motivation in Higher Education

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Table of Contents

List of Tables

List of Figures

Abstract

As technology becomes increasingly integrated with education, research regarding relationships between students' computer-related attitudes, affect, and motivation following technological difficulties is paramount in improving learning experiences. Previous research evaluating motivation and emotions in education has employed Weiner's Attribution Theory (1985), which proposes that perceived causal attributions made following failure events influence attribution-based emotions and subsequent actions. The present research assesses relationships between computer-based attributions and emotions following hypothetical scenarios and experimentally manipulated computer errors for university students from an eastern, research-intensive Canadian university ($N$ = 349). The findings of this multi-study investigation presented significant relationships between computer-related attributions and emotions relative to both hypothetical scenario and experimental conditions. While hypothesized negative effects of stable attributions were observed across studies, results for personally controllable and external attributions were inconsistent. In consideration of the present findings, as well as a lack of research exploring university students' responses to technological challenges as informed by Attribution Theory, further research in which these effects are longitudinally replicated is warranted. Implications and future directions for computer-related motivational processes are also discussed.

Abrégé

Les technologies de l'information et de la communication sont de plus en plus intégrées aux contextes éducatifs. Afin d'améliorer l'expérience des étudiants, il est crucial de comprendre les relations entre les attitudes, émotions et motivations des étudiants face aux difficultés technologiques qui peuvent survenir dans ces contextes. Des études antérieures sur la motivation et les émotions des étudiants ont utilisé la théorie de l'attribution de Weiner (1985), qui propose que les attributions causales perçues par les étudiants suite à un échec influencent les émotions qui découlent de ces attributions, ainsi que les actions qui s'ensuivent. La présente recherche a évalué les relations entre les attributions et les émotions liées à l'utilisation d'ordinateurs chez des étudiants d'une grande université de l'Est canadien ($N$ = 349), dans le contexte de scénarios hypothétiques ainsi que face à erreurs informatiques expérimentalement induites. Les résultats de cette recherche indiquent la présence de relations significatives entre les attributions et les émotions liées à l'utilisation d'ordinateurs dans les deux contextes étudiés. Alors que les effets négatifs anticipés des attributions stables ont bel et bien été observés dans les deux études, les résultats quant aux attributions personnellement contrôlables et externes ont été non concluants. Compte tenu de ces observations, ainsi que d'un manque de recherche sur les réponses des étudiants face aux échecs technologiques, la reproduction de ces résultats dans le contexte d'une étude longitudinale serait souhaitable. Les implications de ces résultats sont discutées, et des pistes vers de futures recherches sur les processus motivationnels liés à l'utilisation d'ordinateurs en contexte éducatif sont également suggérées.

## Introduction

Technology use and attitudes toward computing in education are becoming increasingly popular topics in recent research within educational psychology, particularly in post-secondary education (Hannon, 2013; Littlejohn, Beetham, & McGill, 2012). Considering the prevalence of technology integration with education, it is arguable that the pedagogical use of information communication technology (ICT) is a cornerstone of personalized learning in teacher education (Jones & McLean, 2012). In a recent investigation of ICT use in European higher education, motivation and learning strategies were found to predict educational platform use, indicating important relationships between motivation and educational technology usage, as well as potential effects on performance (Valentín et al., 2013). Recent research has also highlighted the importance of examining learning technologies and their impact on student learning outcomes (Hove & Corcoran, 2008), with student motivation and technology use having also been studied in relation to game-based e-learning (Ghergulescu & Muntean, 2012), student attitudes toward computer-based assessment (Deutsch, Herrmann, Frese, & Sandholzer, 2012), and social media as an educational tool (Tess, 2013). Although technology has permeated education in many different ways, there is still a need to provide support for digital literacy in students so as to facilitate optimal learning and academic success (Littlejohn et al., 2012).

As technology increasingly mediates the learning experiences of university students (i.e., with programs required to complete course assignments, web-based learning tools, growing online universities), it is important to consider students' needs with regard to such technologies. Learning technology has been shown to facilitate university students' self-directed learning, especially at universities with large student-to-faculty ratios (Deepwell & Malik, 2008), but increased guidance and support in using new learning technologies is needed. In their study of

250 graduate and postgraduate students, Deepwell and Malik found that 80% of students agreed technologies were important to their learning and 64% agreed that learning technology had positive effects on their attitudes toward independent study. Although 95% of students reported a high level of skill in using technology, requests for more guidance on how to use learning technologies specific to the university were also consistently observed. Amidst the technological revolution evident in higher education, there is also evidence that some students do not view learning technology as significantly effective in enhancing learning experiences (McCabe & Meuter, 2011).

A need for change in the way universities structure social-technological practices has been conveyed through various studies in recent years and continues to be a concern. It has been argued that education practices are not up to date in helping students use Web 2.0 technologies (e.g., Twitter, Prezi, Dropbox) to their fullest potential, or in a way that encourages students to practice in-depth collaborative eLearning (Lim, So, & Tan, 2010). The influence of information technology (IT) in relation to education practices has effects on both students and faculty at the university level. In their review of past relationships between academic and IT professionals, Salmon and Angood (2013) raised the issue that students' learning with technology may be hindered by a long-established opposition between faculty and IT professionals and that a change is needed if universities are to overcome challenges of education in the 21st century. The importance of examining the implementation of e-learning systems in university settings by practitioners has also been highlighted in recent research assessing university e-learning implementation (Hannon, 2013). An examination of motivational factors that influence students' experiences and relationships with educational technologies is therefore essential in improving students' learning. More specifically, student experiences with technological problems must be

examined in order to bridge the gap between IT and academic instruction, and subsequently encourage persistence in technology-related learning environments.

With respect to instructional technology, motivational predictors of adaptive approaches to technology use and responses to challenges have been previously explored mainly in terms of technology-related self-efficacy, anxiety, interest, and usage (Bates & Khasawneh, 2007; Marcoulides, Stocker, & Marcoulides, 2004; Moos & Azevedo, 2009a; Sheng, Jue, & Weiwei, 2008). Beyond these general concepts, there is presently a lack of motivation research investigating how students' causal attributions regarding computer problems affect their experiences and attitudes with regard to technology used for educational purposes. Web-based education is becoming a critical area of research, with growing importance placed on emotional experiences related to technology and education (Nummenmaa & Nummenmaa, 2008). However, despite emerging research on students' general attitudes surrounding technology use in academic settings, few studies to date have adapted existing theoretical paradigms concerning achievement motivation and emotions to look at how students respond to specific technological challenges. Given the increasing emphasis on the role of students' emotions as important indicators of academic motivation and predictors of study behaviors in web-based learning environments, further investigation of their antecedents (i.e., causal attributions) within the context of educational technology is warranted. As the use of computers and other educational technology continues to increase (Moreno et al., 2012), it is therefore essential to examine the implications of motivational variables, such as causal attributions, on students' emotional responses to technological challenges experienced in academic contexts.

## Literature Review

### University Students' Motivation and Emotions Concerning Technology

**Anxiety.** Computer anxiety has been the predominant focus of research on computer-related emotions since the 1980's. Since computers began to be integrated into everyday life, including for educational purposes, computer anxiety has been studied in hundreds of research articles (Powell, 2013). In her literature review of computer anxiety research from the 1990's and 2000's, Powell categorized computer anxiety research into three main areas: antecedents, correlates, and outcomes. Powell's extensive literature review of papers on computer anxiety reviewed 276 articles in total, however, the present paper will focus on articles from 2000 onward due to the fast pace with which computers and the societal role they play change.

***Antecedents of computer anxiety.*** General themes of antecedents of computer anxiety identified by Powell included personal characteristics and interactions between individuals and computers. Personal characteristics of students examined with computer anxiety include gender, age, other anxieties (e.g., math anxiety), level of education and major, and personality traits. The relationship between computer anxiety and gender has been one of the most popular areas of research within computer anxiety and remains a debated topic due to contradictory findings. Although many studies examining children, adults, and seniors have found females to report more computer anxiety compared to males (Broos, 2005; Karavidas, Lim, & Katsikas, 2005; Rees & Noyes, 2007), research has shown that university students are much less likely to show a gender difference in computer anxiety (Powell, 2013).

Although female university students may be less susceptible to computer anxiety compared to females in other age groups or occupations, some studies have shown female university students to report significantly more computer anxiety compared to male university

students (Beckers & Schmidt, 2003; Durndell & Haag, 2002; McIlroy, Bunting, Tierney, & Gordon, 2001). For example, a study of 300 undergraduate students who were given laptops by their university revealed females to be more anxious and use the computer less often compared to males when assessed annually over the course of three years (Mitra & Steffensmeier, 2000). Overall, students reported an increase in positive attitudes and a decrease in anxiety concerning academic computing over the course of the study, likely due to the exposure and experience gained with laptops over the four years. Todman and Day (2006) further found psychological gender (measured in levels of individual masculinity and femininity) to similarly predict computer anxiety but not biological gender in a study of 138 undergraduate students. Additionally, an overview of research on gender differences in computer learning by Cooper (2006) spanning from 1986 to 2006 regarding computer learning, anxiety, attributions, and stereotype threat suggested a "digital divide" between males and females deeply rooted in computer anxiety and its antecedents, in which females are disadvantaged when learning with computers relative to males. More specifically, the author provided evidence to suggest that computer-related attributions and stereotype threats lead to gender differences in computer anxiety that, in turn, results in differing attitudes and performance concerning computing-related tasks.

Conversely, there is an international body of research on university students showing non-significant findings regarding computer anxiety and gender (Anthony, Clarke, & Anderson, 2000; Arigbabu, 2006; Stephens, 2001; Tekinarslan, 2008; Teo, 2006, 2007). For example, one year-long longitudinal study of computer anxiety in 228 professionals, 67 graduate students, and 220 undergraduate students revealed no significant relationships between gender and computer anxiety (Bozionelos, 2001). Other studies that examined gender differences in 697

undergraduates (Compton, Burkett, & Burkett, 2003), 331 undergraduate business students (Havelka, Beasley, & Broome, 2004), and 242 graduate and undergraduate students (Korukonda, 2005) found similar results. There have also been findings indicating gender differences in computer anxiety have changed over time. For instance, Popovich, Gullekson, and Morris (2008) found females to have significantly more computer anxiety compared to males in 1986 but not in 2005 in a study of 254 undergraduate students. Additionally, a study of 1051 undergraduates found that for psychology students, males' computer anxiety decreased significantly over a six-year period (1992-1998) whereas females' computer anxiety ratings did not significantly change (Todman, 2000). Overall, findings on relationships between gender and computer anxiety for university students are mixed with significant relationships having been theorized as due, at least in part, to antecedents such as computer self-efficacy, accessibility, and prior experience.

As for the antecedent of age, there is relatively little recent research on computer anxiety as predicted by age in university students. One study of 176 South African undergraduates (Anthony et al., 2000) and another study of 162 Nigerian undergraduates in education (Arigbabu, 2006) found no significant relationships between computer anxiety and age. Although another study on 214 undergraduate students revealed a significant relationship between computer anxiety and age (Orr, Allen, & Poindexter, 2001), these findings were theorized to be influenced by other factors that correlate with age (i.e., experience).

Other demographic antecedents of computer anxiety identified by Powell (2013) were major and education level, however, there are relatively few articles examining these variables in university students. Concerning business majors, there is evidence showing IT students to have lower computer anxiety compared to psychology students (Todman, 2000), as well as accounting and management and information systems majors to report less computer anxiety compared to

other business majors (Havelka et al., 2004). Another study of 124 undergraduate students revealed non-business majors to have more computer anxiety compared to business majors at the beginning of a semester but not at the end (Vincent, Meche, & Ross, 2002). Additionally, undergraduates have been found to have higher computer anxiety compared to graduate students and professionals (Bozionelos, 2001). Although there is some support for a significant relationship between computing anxiety and one's major, there is also evidence to the contrary (Lamberton, Fedorowicz, & Roohani, 2005). In their examination of undergraduate accounting and accounting information systems (AIS) majors, Lamberton et al. did not find computer anxiety to significantly predict choice of major. Overall, there have been some relationships identified between computer anxiety and education level or major, however more research is needed in this domain to examine the extent to which these effects are due to possible mediators such as computing experience.

Research on dispositional antecedents of computer anxiety has further shown it to correspond significantly to anxieties in other domains. For example, trait anxiety was found to be positively associated with computer anxiety in a study of 280 undergraduates (Thatcher & Perrewe, 2002), and to significantly predict computer anxiety in another study with 86 undergraduate education majors (Rovai & Childress, 2002). Beckers, Wicherts, and Schmidt (2007) examined state and trait anxiety in two studies of first-year psychology students and found computer anxiety to be more strongly correlated with trait anxiety than state anxiety. In this study, state anxiety was presumed to occur because of pre-established computer anxiety. Significant contributions of general computer anxiety toward computer-mediated communication anxiety were found in a study with 193 undergraduate students (Brown, Fuller, & Vician, 2004), where anxiety specific to computer-mediated communication was positively linked to attitudes

toward computer-mediated communication. Other anxieties that have been positively linked to computer anxiety also include e-mail anxiety (Fuller, Vician, & Brown, 2006), social anxiety (Norris, Pauli, & Bray, 2007), Internet anxiety (Thatcher, Loughry, Lim, & McKnight, 2007), and Y2K anxiety (Goldstein, Dudley, Erickson, & Richer, 2002). Evidence for relationships between computer anxiety and other anxieties indicates that computer anxiety may generalize to other computing domains, representing a domain-general construct of technology-related anxiety.

Research examining relationships between computer anxiety and personality has revealed significant findings in relation to a number of personality traits. For instance, computer anxiety has been found to positively relate to neuroticism (Korukonda, 2005, 2007; Korzaan & Boswell, 2008). In addition to neuroticism, computer anxiety has also been negatively related to openness (Anthony et al., 2000) and agreeableness (Korukonda, 2007). A study of 94 undergraduates by Gaudron (2000) further showed that compared to students with lower computer anxiety, those with higher computer anxiety were also more introverted, less open to experience, and less emotionally stable. Computer anxiety has also been found to negatively relate to technophobia and extraversion (Korukonda, 2005), as well as personal innovativeness in IT (measured as one's willingness to try new IT; Thatcher & Perrewe, 2002). In addition to significant relationships with personality traits, existing research has examined links to individualism and collectivism but found no significant relationships (Srite, Thatcher, & Galy, 2008). Overall, research has explored several antecedents of computer anxiety including gender, age, level of education and major, other anxieties, and personality traits. Although there is strong support for some of these antecedents, many findings are mixed and possibly confounded with other variables such as computing experience.

In addition to the aforementioned personal characteristics that predict computer anxiety, there exists strong empirical support for computing experience variables as moderators of the effects of individual differences on computer anxiety including computer ownership, experience or use, and computer training. There are relatively few recent studies examining interactions between computer anxiety and ownership (owning a computer) in university students (likely due to an understandable confound with computing experience), however, all of them found negative relationships between ownership and anxiety (Orr et al., 2001; Tekinarslan, 2008; Teo, 2006, 2008). Similarly, much of the research with university students has found a negative relationship between computer anxiety and experience or use (Anthony et al., 2000; Beckers & Schmidt, 2003; Bozionelos, 2001, 2004; Hackbarth, Grover, & Yi, 2003; Havelka et al., 2004; Maki, Maki, Patterson, & Whittaker, 2000; McIlroy, Sadler, & Boojawon, 2007; Mitra & Steffensmeier, 2000; Orr et al., 2001; Tekinarslan, 2008; Wilfong, 2006). For examples, one study with 469 university business students found computing experience and computer anxiety to be negatively related (Fagan, Neill, & Wooldridge, 2003) as did another study on usage of internet resources in 520 undergraduates (Althaus & Tewksbury, 2000). Conversely, Todman and Drysdale (2004) found the number of positive experiences with computers to be negatively related to computer anxiety in a sample of 154 first-year psychology students. Despite this evidence for a negative relationship between computer experience and anxiety, other studies show mixed results (McIlroy et al., 2001) or non-significant relationships (Rovai & Childress, 2002; Saadé & Kira, 2007).

As for human-computer interaction antecedents (i.e., computer experience) of computer anxiety in relation to computer training, recent research on university students has also revealed mixed findings with only about half of the studies on this topic showing computer anxiety and

computer training to be negatively related (Gunter, 2001; Maki et al., 2000; Orr et al., 2001; Rovai & Childress, 2002). For example, where some studies show students to have significantly less computer anxiety after an information systems course (Buche, Davis, & Vician, 2007) or multiple computing courses (Korukonda, 2007), other studies on university students show no significant relationships between computer training and anxiety (Long, DuBois, & Faley, 2008; Namlu, 2003; Torkzadeh, Chang, & Demirhan, 2006; Zhao, Mattila, & Tao, 2008). In sum, similar to findings concerning dispositional antecedents of computer anxiety, findings suggest that some elements of computing-related experiences can also impact computer anxiety (i.e., experience or use), with findings remaining mixed for others (i.e., ownership). It should be kept in mind that although experience, ownership, and training are all very closely connected, the predominant assumption in computer anxiety research is that more experience with computers is associated with lower computer anxiety in university students.

***Correlates of computer anxiety.*** The second area of research related to computer anxiety is its correlates that typically include self-efficacy, attitudes, perceived ease of use, perceived usefulness, and satisfaction (Powell, 2013). Overall, studies with significant findings revealed a trend of negative relationships between and computer anxiety its correlates, with the exception of perceived usefulness. Research has found mainly negative correlations between computer anxiety and computer self-efficacy in university students (Durndell & Haag, 2002; Fagan et al., 2003; Havelka, 2003; Johnson & Marakas, 2000; McIlroy et al., 2007; Scott & Walczak, 2009; Thatcher & Perrewe, 2002; Thatcher, Zimmer, Gundlach, & McKnight, 2008). Both general and application-specific computer self-efficacy has been found to negatively correlate with computer anxiety (Hasan, 2006; Johnson, 2005), with computer anxiety shown to be more strongly related to computer self-efficacy than computer use and experience (Wilfong, 2006). Computer self-

efficacy has also been found to mediate the relationship of computer anxiety and perceived ease of use in a sample of 645 undergraduate students after a semester of using learning management system software, with high computer self-efficacy found to buffer the negative effects of computer anxiety on perceived ease of use (Saadé & Kira, 2009).

Although computer self-efficacy has been identified as an important component in measuring computer anxiety (Beckers & Schmidt, 2001), some studies have found differing results. A study of 131 undergraduate students who received training to use a self-checkout machine in the library revealed no significant relationship between post-training self-efficacy and technology anxiety (Zhao et al., 2008). However, it should be noted that self-efficacy in this study was specific to the machine for which students received training and technology anxiety was assessed using a domain-general measure. Another study of 347 undergraduate students from introductory computer classes found computer anxiety to influence computer self-efficacy but not Internet self-efficacy. Compared to students with high computer anxiety, students with low computer anxiety had significantly greater increases in computer and Internet self-efficacy over time (Torkzadeh et al., 2006).

With respect to correlations between computer attitudes and anxiety, there have been relatively few studies on university students. Positive and negative beliefs toward computers, as well as affective feelings (i.e., disliking), have been previously identified as factors of a computer anxiety scale in a study of 409 undergraduate psychology students (Beckers & Schmidt, 2001), and correlations examined between computer attitudes and anxiety have shown negative relationships (Durndell & Haag, 2002; Popovich et al., 2008). Similarly, research has shown computer anxiety to negatively correlate with perceived ease of use (Kumar, Rose, & D'Silva, 2008; Saadé & Kira, 2006, 2007, 2009; Zhao et al., 2008). A study of 116 graduate and

upper-level undergraduate students also found the relationship between computer experience and perceived ease of use to be mediated by computer anxiety, suggesting that more computer experience increased perceived ease of use for students by indirectly reducing their computer anxiety (Hackbarth et al., 2003). The relationship between computer anxiety and perceived usefulness, however, has been found to be positive in research on technology acceptance involving 114 undergraduate university students (Saade & Kira, 2006). Lastly, research on university students that has examined correlations between computer anxiety and satisfaction is minimal. Whereas one study of 295 university students showed computer anxiety to have a negative relationship with e-learning satisfaction (Sun, Tsai, Finger, Chen, & Yeh, 2008), another study of 131 undergraduate students found no significant relationships between technology anxiety and satisfaction (albeit after a training exercise; Zhao et al., 2008).

***Outcomes of computer anxiety.*** Outcomes of computer anxiety comprise the third theme of research in this domain (Powell, 2013). Performance and intent to use computers were the two main outcomes assessed in computer anxiety research on university students. Studies that examined effects of computer anxiety on performance have produced mixed results. About approximately half of such studies reveal no significant effects (Lee, Hong, & Ling, 2001; Stephens, 2001; Williams & McCord, 2006), with the other half showing negative relationships between computer anxiety and performance (e.g., computer skills, Johnson & Marakas, 2000; course performance, Buche et al., 2007). However, a study of 75 undergraduates found students' computer anxiety to negatively correlate with their predicted final grades but not actual grades (Beckers, Rikers, & Schmidt, 2006), with a positive relationship between computer anxiety and grades being found in study with a notably small sample ($N = 15$; DeSai, 2001). Additionally, decreased computer anxiety has been linked to an increase in learning computer skills in a pre-

post study of 184 pre-service education students from a program in which laptops were provided to all students (Kay, 2008).

Recent research has also found negative relationships between computer anxiety and university students' intent to use computers (Al-Busaidi, 2009; McIlroy et al., 2007), as well as between technology anxiety and self-service technology usage intent (Oyedele & Simpson, 2007). An examination of 228 Taiwanese nursing students revealed a negative correlation between computer anxiety and intent to use online classes (Tung & Chang, 2008). Buying textbooks online was also found to negatively relate to computer anxiety in a study of 71 undergraduate students (Lester & Yang, 2007). There are, however, some studies that found no significant relationship between computer anxiety and intent to use computers (Korzaan & Boswell, 2008; Zhao et al., 2008).

The extensive literature on computer anxiety reveals important implications for student experiences with technology and learning. General themes of antecedents of computer anxiety for university students include individual differences in gender, age, other anxieties, education level or major, and personality traits, as well as human-computer interaction variables of computer experience, training, and ownership. Computer anxiety has been found to correlate with computer self-efficacy, attitudes, perceived ease of use, perceived usefulness, and satisfaction, as well as to predict outcomes of performance and intent to use computers. Although some findings have been mixed, it can be generally concluded that computer anxiety is not conducive to students' learning and achievement and is negatively associated with other positive predictors of learning. Computer experience has also been identified as a key indicator of computer anxiety, and thus, has been theorized to be the main factor in determining computer anxiety in relation to other precursors such as age and ownership.

**Self-efficacy and competence beliefs.** Self-efficacy and competence beliefs involve an individual's belief in his or her ability to complete a task, and have been well established as predictors of learning and achievement in educational psychology research over the past few decades. Benefits of self-efficacy evidenced in research regarding academic performance warrants the examination of university students' computer-self efficacy in relation to learning, achievement, and other motivational variables. In recent years, computer self-efficacy has emerged as a specific topic of interest in studies examining effects on student learning as mediated by technology. Further, there exists strong empirical support for the link between computer self-efficacy and learning processes and outcomes in computer-based as well as online learning environments. Overall, students with higher computer self-efficacy tend to display higher levels of self-monitoring during learning and have higher achievement in computer-mediated learning environments compared to students with low computer self-efficacy (Moos & Azevedo, 2009a).

One area of recent research on hypermedia learning in university student has examined the relationships between self-efficacy, prior domain knowledge, and specific self-monitoring processes (Moos & Azevedo, 2009b). In one pre-post study of 68 undergraduates majoring in education, students completed a training session followed by a self-efficacy questionnaire prior to a hypermedia task requiring them to Think Aloud to gauge their self-monitoring during learning. Results revealed self-efficacy to be significantly and positively correlated with specific monitoring processes (e.g., monitoring understanding and progress toward goals), with self-monitoring further found to mediate the effects of self-efficacy on hypermedia learning outcomes. Another area of research in this domain concerns the relationship between self-efficacy, its antecedents, and learning outcomes concerning online learning in higher education.

One study in particular examined the mediational role of self-efficacy with 288 university students (Bates & Khasawneh, 2007) showing multiple variables (i.e., previous success, pre-course training, online learning system anxiety) to predict online learning self-efficacy that, in turn, predicted outcome expectations, mastery perceptions, and hours spent using online learning technology.

Research also shows computer self-efficacy to play a key role in university students' experiences in computer-based learning environments (CBLEs). In a recent literature review, Moos & Azevedo (2009a) found computer self-efficacy to be related to learning outcomes and processes in CBLEs, with both behavioral and psychological factors being related to self-efficacy. With regards to psychological factors, positive attitudes toward CBLEs have been found to positively correlate with computer self-efficacy, whereas negative attitudes have been found to correspond with low computer self-efficacy (Torkzadeh & Van Dyke, 2002). Curiosity and enjoyment using CBLEs have also been found to positively relate to computer self-efficacy (Wang & Newlin, 2002). Additionally, intrinsic motivation has been found to mediate the positive effects of computer self-efficacy on computer use (Deng, Doll, & Truong, 2004).

In addition to psychological factors, behavioral factors have been found to significantly correlate with computer self-efficacy. Although experience with CBLEs has been positively linked to computer self-efficacy (Houle, 1996), findings of relationships between self-efficacy and specific types of computer use (e.g., for differing tasks or programs) have been inconsistent (Hasan, 2003). For example, specific training methods using CBLEs (i.e., behavioral modeling vs. tutorial training) have been found to have differential effects on computer self-efficacy, with behavioral modeling predicting higher self-efficacy as compared to traditional instruction (Chou,

2001). Lastly, self-rated computer skills have similarly been found to relate positively to computer self-efficacy (Russon, Josefowitz, & Edmonds, 1994; Schunk & Ertmer, 1999).

With regards to relationships between computer self-efficacy and CBLE learning outcomes, findings have been mixed. While some research has shown positive correlations with learning (Thompson, Meriac, & Cope, 2002), other studies have shown the correlation between self-efficacy and learning outcomes to fluctuate throughout the learning process (Mitchell, Hopper, & Daniels, 1994). Certain dimensions of self-efficacy have also been found to have differential relationships with CBLE learning outcomes (Holladay & Quiñones, 2003). With respect to self-efficacy and learning processes within CBLEs, computer self-efficacy has been linked to CBLE use (Brosnan, 1998), with students reporting higher self-efficacy tending to make more constructive learning decisions.

In terms of research on the measurement of computer self-efficacy, general computer self-efficacy has been examined in a study evaluating a composite measure summing together task-specific subscales showing significant effects on computer anxiety, affect, and computing competence (Downey & McMurtrey, 2007). In this study, surveys of 310 students at Naval Reserves Officers Training Corps universities and the U.S. Naval Academy were administered self-report measures of computer attitudes and anxiety, computing competence, as well as general, global, and application-specific self-efficacy. SEM analysis revealed application-specific self-efficacy (e.g., self-efficacy for using word processing programs) to be significantly related to overall competence, computer anxiety, and affect in anticipated directions. Application-specific self-efficacy was also found to predict overall perceived computing competence better than the general computer self-efficacy measure, although the global scale

was a better predictor of anxiety and affect. Overall, this study supports the examination of computer self-efficacy via measures that are specific to applications and tasks.

**Intrinsic motivation.** The concept of intrinsic motivation has taken on various definitions relative to the authors who describe it and the domain in which it is examined. For the purposes of the present literature review, intrinsic motivation refers to "behaviors performed in the absence of external rewards" (Goudas, Biddle, & Underwood, 1995, pp. 89-90). Although university students' intrinsic motivation related to technology has been indirectly explored in research conducted on related constructs (i.e., goals, self-efficacy, acceptance), there is to date no distinct body of research focused solely this topic likely due to confounded terminology and an array of measures utilized to assess constructs related to intrinsic motivation regarding computer technology (e.g., interest, intentions, value, enjoyment, engagement, flow, curiosity, exploration). Overall research has shown intrinsic motivation, and these related constructs, to be positively related to computer-self efficacy, learning, and performance, with research showing university students to prefer technology-blended learning to traditional methods because of the personal benefits received from individualized learning (Usun, 2004).

With respect to studies that have directly measured intrinsic motivation regarding computer use in university students, there have been some significant findings. In a study of 84 undergraduate students learning through hypermedia (e.g., the World Wide Web), students who were high in both intrinsic and extrinsic motivation to learn were found to use more self-regulated learning strategies and to perform better on post-test measures compared to students who were low in either intrinsic or extrinsic motivation (Moos, 2010). A study by Savage, Birch, and Noussi (2011) with 422 students in a Faculty of Technology further showed that although

most students were extrinsically motivated, those who were also intrinsically motivated benefited more from flexible assessment methods.

Intrinsic motivation has also been closely examined as a predictor of technology acceptance and university students' use of web-based learning systems, particularly with measures of enjoyment. Perceived computer usefulness, ease of use, behavioral intention, and enjoyment were found to positively predict computer use in a sample of 121 business college students from China (Sheng et al., 2008). Results also showed enjoyment to significantly predict intention to use web-based learning systems. Overall, studies suggest that intrinsic motivation, and related constructs, concerning students' use of computers in academic contexts has a positive influence on learning, performance and usage, however, this area of research is relatively small and the constructs not clearly or consistently defined.

**Goals.** Goals have long been identified as significant contributors to students' motivation and persistence, as well as to self-regulatory processes in academic contexts (Zimmerman, 2008). Achievement goal orientations in particular, have consistently been linked to students' learning, achievement, and other motivational variables such as intrinsic motivation (Maehr & Zusho, 2009). A current framework of achievement goals employs a 2 x 2 taxonomy of approach vs. avoidance and mastery vs. performance goals, with empirical evidence showing differential outcomes for the four resulting goal orientations. Both mastery- and performance-approach goal orientations have been positively linked with learning and achievement, while performance-avoidance goal orientation has been found to negatively relate to intrinsic motivation in university students (Elliot & Murayama, 2008). Since there has been strong empirical support for effects of students' goal orientations on achievement, it has also been deemed important to examine goals in the context of learning with technology.

Although there is not an overwhelming amount of research on university students' goal orientations relevant to academic technology use, there are some studies that show significant relationships between computing-related goals, learning, and related motivational variables. For students enrolled in online classes, those high in mastery learning orientation have been found to report higher perceived quality and satisfaction with their online course as compared to those reporting low mastery goal orientation levels (Kickul & Kickul, 2006). An interaction effect between positive personality and mastery goal orientation on quality of learning was also found in this sample of 241 undergraduate and graduate students. Another study of 101 first-year nursing (BScN) students from a laptop-based program in Canada found mastery goal orientation in relation to course performance to be positively correlated with age, with performance approach goals being negatively related to frequency of casual online activity and performance avoidance corresponding to lower GPAs for students in biology & biochemistry courses (Goldsworthy, Goodman, & Muirhead, 2005). Goal orientations have also been explored in relation to goal-performance discrepancy in videogame-based U.S. military training. A study by Brusso, Orvis, Bauer, and Tekleab (2012) of 185 university students revealed that those who experienced larger initial goal discrepancy during their first mission to perform worse in the following mission compared to students whose performance was close to their goal for that mission. Additionally, students with a performance-avoidance goal orientation performed most poorly compared to all other students.

In examining how goal orientation influences ease of learning perceptions and intent to learn new uses of technology, there is evidence of an interaction between goal orientations and ease of learning a new task. An experimental study by Loraas and Diaz (2009) with 195 junior-level accounting program university students revealed high perceptions of ease of learning and

performance orientation to predict higher level of commitment to learn new technology. However, when perceived ease of learning was low, mastery orientation predicted higher commitment to learning new technology. Performance orientated students were only commitment to learning a new technology when the perceived ease of learning a new task was high. For those with a mastery orientation, ease of learning did not affect intent to learn new technology. In sum, findings show positive effects for both learning and performance goal orientations in relation to technology similar previous research on university students' goal orientations, depending on the computing situation.

## Motivation Beliefs and Emotions in Higher Education

**Control-value theory.** Control-Value Theory (Pekrun, 2006) asserts that individuals' achievement emotions are formed as a function of appraisals of control and value. Situation-outcome expectancies, action-control, and action-outcome expectancies are said to comprise total outcome expectancies, which are appraisal antecedents of achievement emotions. Situation-outcome expectancies are based on appraisals of external control over an event, where the outcome for an event will be either positive or negative without an action from the individual. An individual's belief that he or she will fail an exam without studying is an example of a situation-outcome expectancy. Action control expectancies are based on one's belief in their ability to initiate and perform an action. For instance, action control expectancy would be an individual's belief that he or she is able to study for an exam. Lastly, action-outcome expectancies are based on an individual's belief that his or her actions will elicit some positive outcome or better a negative outcome (i.e., that studying will result in a successful grade). These expectancies of achievement are mainly based on perceptions of internal control over an event (i.e., controllable causal attributions) and produce differential achievement emotions based on an

individual's value of the activity or outcome (see Table 1). It is also important to note that appraisals are not always conscious because they can become automatized over time. The structures and principals surrounding Control-Value Theory are also said to be universal across domains and cultures.

Achievement emotions, defined as emotions directly related to achievement activities or outcomes, have been identified as prospective, retrospective, or activity related based on appraisal antecedents. Prospective outcome emotions (i.e., hope, anxiety, hopelessness) are determined by an individuals' perceived control over whether he or she will be able to achieve success or avoid failure. Retrospective outcome emotions (i.e., pride, shame anger) are determined by an individual's perception of the cause of success or failure to be internal or external to himself or herself. Lastly, activity-related emotions (i.e., enjoyment, boredom) are related to control and value appraisals directly related to the action, rather than the valence of the outcome. For instance, an individual who highly values studying for biology and has high control over their studying will likely experience enjoyment, whereas an individual who highly values the same action but has little control over their studying will likely experience frustration. The concept of appraisals as antecedents to emotions is understood to be particularly important for university students who must learn to adapt to new settings (Pekrun & Stephens, 2010).

Achievement emotions outlined in Pekrun's Control-Value Theory (2006) have also been differentiated as state and trait achievement emotions. Whereas state emotions are specific to a situation at one point in time (i.e., anxiety prior to a certain exam), trait emotions reflect more typical, recurring emotions experienced by an individual in achievement settings. Pekrun highlights that achievement emotions are influenced by multiple antecedents that may differ depending on the emotion, and that emotions are often domain specific depending on the

Table 1

*The Control-Value Theory: Basic Assumptions on Control, Values, and Achievement Emotions*

| | Appraisals | | |
|---|---|---|---|
| Object focus | Value | Control | Emotion |
| Outcome/prospective | Positive (success) | High | Anticipatory joy |
| | | Medium | Hope |
| | | Low | Hopelessness |
| | Negative (failure) | High | Anticipatory relief |
| | | Medium | Anxiety |
| | | Low | Hopelessness |
| Outcome/retrospective | Positive (success) | Irrelevant | Joy |
| | | Self | Pride |
| | | Other | Gratitude |
| | Negative (failure) | Irrelevant | Sadness |
| | | Self | Shame |
| | | Other | Anger |
| Activity | Positive | High | Enjoyment |
| | Negative | High | Anger |
| | Positive/Negative | Low | Frustration |
| | None | High/Low | Boredom |

individual. Causal attributions (see section on Weiner's Attribution Theory) are also identified as antecedents of achievement emotions, with external attributions likened to situation-outcome expectancies and internal attributions likened to action-control and action-outcome expectancies. Individual and social determinants of achievement emotions (i.e., achievement goals, personality, self-regulation, etc.) are also described as important factors that influence control and value appraisals. Importantly, appraisals, emotions, and effects on learning and achievement are depicted as feedback loops in Control-Value Theory (see Figure 1), with one's social environment and previous success included in the model. Control-Value Theory suggests that

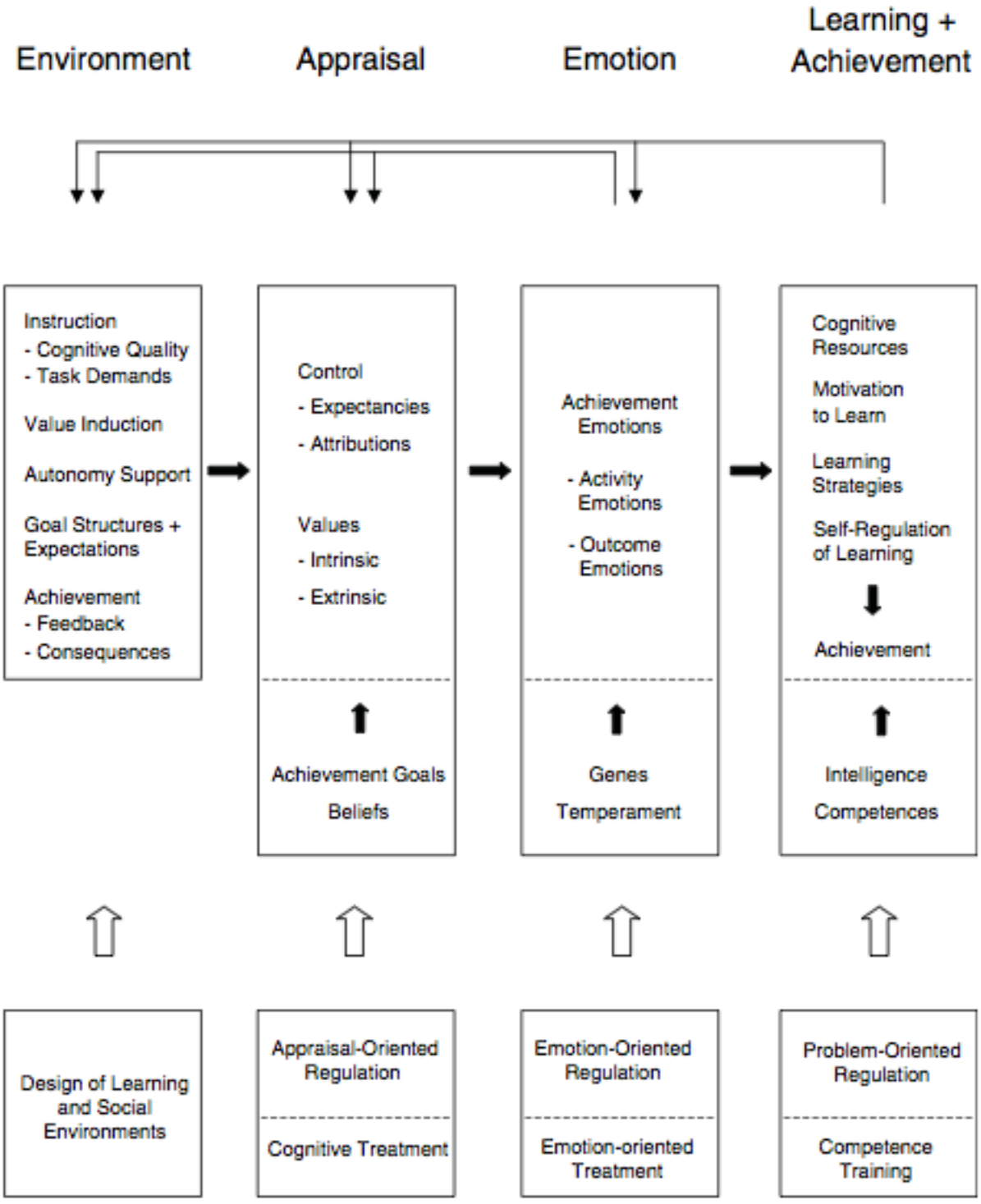


*Figure 1.* The control-value theory of achievement emotions: Reciprocal linkages between antecedents, emotions, and effects.

students' emotions can be influenced by supporting competence and control, thus providing a framework for more positive appraisals and learning outcomes.

Until the early 2000's, a majority of research on emotions and learning or achievement (including work, tests, performance) revolved around test anxiety, with very little research on other achievement-related emotions, particularly positive emotions (i.e., hope). Due to the lack of research on achievement emotions other than anxiety, Pekrun, Goetz, Titz, & Perry (2002a) conducted five initial qualitative studies that showed students to experience a large variety of emotions with anxiety reported most often and equal reports of positive and negative emotions. These findings led to classifications of academic emotion structures and the construction of the Achievement Emotions Questionnaire (AEQ). The AEQ was quantitatively tested on two samples of university students ($N_1 = 230$, $N_2 = 222$). This model was constructed on dimensions of positive or negative mood valence and activating or deactivating emotions, where activating positive emotions (i.e., enjoyment) are assumed to increase motivation and deactivating negative emotions (i.e., hopelessness) are presumed to decrease motivation. Effects of deactivating positive emotions (i.e., relaxation) and activating negative emotions (i.e., anxiety) are more complex in that such emotions have shown to be both motivating and demotivating (e.g., anxiety may simultaneously decrease intrinsic motivation and increase extrinsic motivation).

The AEQ assesses nine emotions that are either prospective, retrospective or activity emotions, comprising four dimensions of valence and activation: positive activating (enjoyment, hope pride), positive deactivating (relief), negative activating (anger, anxiety, shame), and negative deactivating (hopelessness, shame). The AEQ is comprised of 24 scales that measure affective, cognitive, motivational, and physiological components of class-related, learning-related, and test-related emotions. Included in the AEQ are of categories of academic situations

(i.e., attending class) for assessment of state, trait, class specific, and domain specific emotions. Most other test anxiety measures have cognitive, affective, and physiological components but not a motivational component, however the AEQ has all four components in measuring academic emotions.

The AEQ was assessed with a 5-point Likert scale (1 = *completely disagree*, 5 = *completely agree*) in a study of 389 Canadian university students along with measures of perceived control and value, motivation, learning strategies, regulation of learning (self vs. external), and GPA from the previous year. Results revealed good reliabilities for scales (alphas ranging from .77 to .93) and correlations of emotion items provided support for constructs used. In terms of internal validity, control-value appraisals and learning/performance outcomes were significantly correlated with achievement emotions. Academic control and value appraisals were both positively correlated with positive emotions (enjoyment, hope, pride, relief) and negatively correlated with negative emotions (anger, anxiety, shame, hopelessness, boredom). Similar relationships were found for measures of motivation, learning strategy, and academic performance. In sum, this research provides empirical support for Control-Value Theory and suggests that adaptive cognitive appraisals (e.g., high control) could lead to more motivating emotions which would in turn, lead to more positive learning outcomes for students.

Research has shown positive emotions such as enjoyment to positively influence motivation and academic performance (Pekrun et al., 2002a; Pekrun, Goetz, Titz, & Perry, 2002b). Empirical findings from seven cross-sectional, three longitudinal, and one diary-based study provided support for the hypothesized relationships between emotions and academic outcomes. Positive activating emotions (i.e., enjoyment, hope, pride) were positively associated with high academic achievement (Pekrun, 2000) and negative academic emotions were

significantly related to course withdrawal and dropout (Ruthig, Hladkyj, Hall, Pekrun, & Perry, 2002). Interestingly, hopelessness and boredom were more strongly related to achievement than test anxiety. These studies provide empirical support for the influence of academic emotions beyond anxiety in educational settings with respect to learning behaviors and achievement (Pekrun et al., 2002a). Additionally, there has been evidence of positive effects of positive activating emotions and negative effects of negative deactivating emotions related to learning and achievement, with complex effects for positive deactivating and negative activating emotions (Pekrun & Stephens, 2010).

Multiple studies have shown test anxiety to be negatively related achievement, however, there is some research indicating that anxiety can be a motivating factor that positively influences performance (Pekrun, Elliot, & Maier, 2006, 2009). Test anxiety and academic achievement have also been found to have a reciprocal relationship in longitudinal research suggesting the effects of achievement on anxiety are stronger than vice versa (Meece, Wigfield, & Eccles, 1990; Pekrun, 1992; Schnabel, 1998). Negative emotions of anger, shame, hopelessness, and boredom have demonstrated negative links to achievement but these emotions have received little attention in educational research (Pekrun & Stephens, 2010).

Concerning the effects of motivation-related appraisals on academic emotions, study of 50 German university freshmen assessed the influence of control and value antecedents, as well as their interaction, on positive state emotions of enjoyment, pride, and contentment (Goetz, Frenzel, Stoeger, & Hall, 2010). An examination of responses collected via personal digital assistants (PDAs) revealed appraisals of control and value to be positively related to enjoyment, pride, and contentment. A significant interaction further showed high perceived control and high value to be optimal for each emotion. The effects of control and value on achievement emotions

remained consistent whether the situation was achievement-oriented or not, showing that these relationships are important within and outside of achievement settings. Pekrun (2009) further evaluated the relationships between achievement goals and emotions on academic performance in a study of 218 undergraduate students showing mastery goals to positively predict enjoyment, hope, and pride, and negatively predict boredom, anger, hopelessness, and shame. In contrast, performance-approach positively predicted feelings of hope and pride, whereas performance-avoidance predicted poorer levels of anxiety, hopelessness, shame, anger, hope, and pride. With regards to achievement, performance was negatively predicted by performance-avoidance goals and positively predicted by both performance-approach goals and, to a lesser extent, by mastery approach goals. Feelings of hope and pride were found to positively predict performance, whereas boredom, anger, anxiety, hopelessness, and shame negatively predicted performance.

In a similar study with 669 first-year Canadian undergraduate students, Daniels et al. (2009) found hopefulness to positively predict mastery and performance approach goals, and helplessness to negatively predict mastery goals. Mastery goals were positively related to enjoyment and negatively related to anxiety and boredom, and performance goals were positively related to anxiety. In a series of five studies, Pekrun, Goetz, Daniels, Stupnisky, and Perry (2010) further examined achievement-related boredom in university students ($N_1$ = 323, $N_2$ = 203, $N_3$ = 122, $N_4$ = 389, $N_5$ = 287), with state assessments showing boredom to be the most frequently reported negative emotion, most often reported in low-control situations, and to relate negatively to perceived control and value. Trait assessments of boredom similarly revealed negative associations with academic control and value and academic performance (GPAs).

**Weiner's attribution theory.** According to Weiner's Attribution Theory, expectancy-related beliefs are assumed to predict emotions, which are also influenced by value appraisals indicated by perceived importance of an event. The development of Weiner's Attribution Theory (1985, 1995, 2006) was heavily influenced by Drive (Hull, 1943; Spence, 1956) and Expectancy-Value theories (Atkinson, 1957; Rotter, 1954; Tolman, 1932), which were two of the most dominant theories of motivation by the 1970's. Atkinson, who proposed that motivation is determined by individual differences, or motives, in addition to expectancy and value, heavily influenced Weiner's development of Attribution Theory. Incentive or value was considered to be affect, in that emotions such as pride were considered to be more than just positive or negative valence, and value was inversely related to expectancy of success (i.e., lower expectancy = more pride). Rotter's concept of *locus of control* was also explored, however, Weiner determined that distinctions between locus *and* control, ability and effort, and success and failure were necessary in examining causal ascriptions (Weiner, 2010).

A combination of outcomes from the aforementioned theorists, as well as Heider (1958), was assumed in Weiner's early theoretical development of attributions of ability, effort, task difficulty, and luck. The early model was a 2 x 2 factorial with causal dimensions of locus and stability, where locus was related to value and stability was related to expectancy. This model was further elaborated upon to include an additional dimension of controllability as well as clarifications of outcomes representing success or failure and the inclusion of more emotions (i.e., pride, guilt, regret, shame, hope, hopelessness). Emotions were also differentiated into categories of attribution-independent (e.g., happiness) and attribution-dependent (e.g., pride), namely emotions experienced immediately following an event as opposed to those experienced following the selection of a causal attribution (see Figure 1). Attribution Theory is therefore

"phenomenological" in that it relies on perceptions of the individual, placing importance on causal properties (locus, stability, controllability) of a perceived reason for an outcome, rather than the veridicality of the belief.

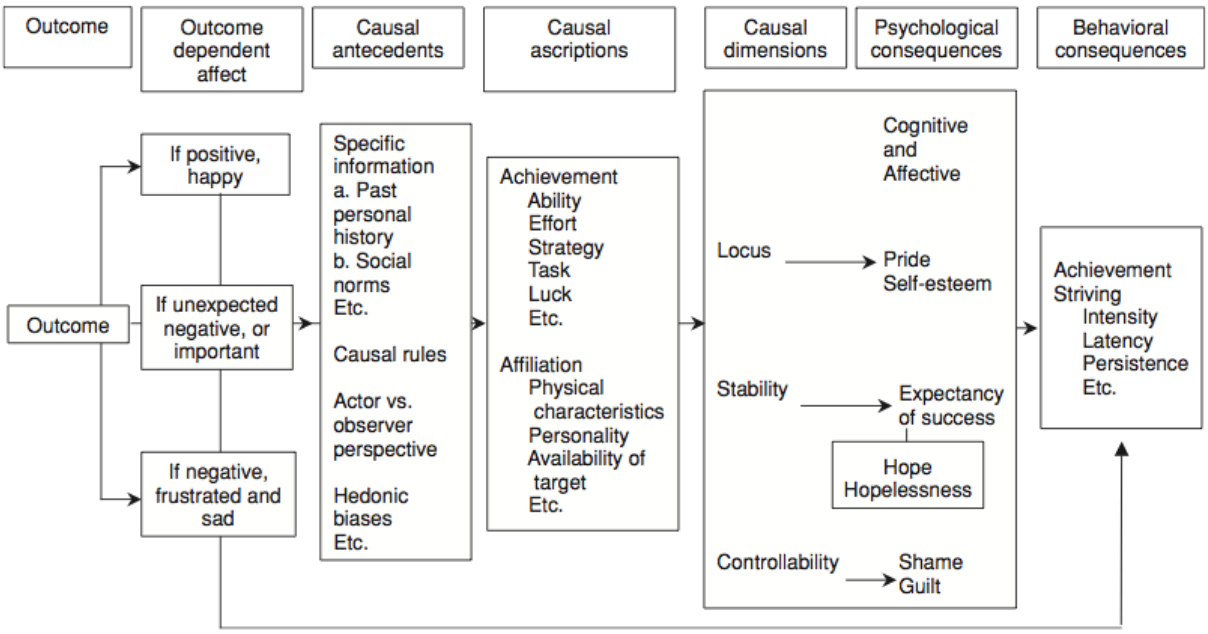


*Figure 2.* Attribution theory of achievement motivation (Weiner, 2010).

In the present version of Weiner's Attribution Theory (1985), it is proposed that an individual undergoes causal search in response to success and failure events, with failure events eliciting greater causal search. Outcomes that are important, negative, or unexpected are proposed to elicit greater causal search. Specifically, there are three properties of causes: *locus* refers to whether an individual believes the cause was internal or external to oneself, *controllability* is described as whether or not an individual believes the cause was controllable by themself or not, and *stability* is the extent to which an individual believes the cause will change or not over time. Weiner believes it is the stability dimension that causes shifts in expectancies,

such that an individual who perceives the cause of an event to be stable will expect the same outcome again. Weiner's Attribution Theory assumes that a success or failure event leads individuals to search for causal explanations for that event, which influences subsequent emotions and actions. Emotions in this model may be outcome-dependent (i.e., happiness) or attribution-dependent (i.e., pride). Pride and self-esteem are assumed to be related to locus of causality, whereas feelings of hopefulness and hopelessness are proposed to be related to the stability dimension. Emotions of anger, gratitude, guilt, and shame have been likewise related to perceptions of controllability.

Similarly, feelings of guilt are said to stem from the controllability of a cause within oneself, however, attributions made for failure events that are internal and uncontrollable have been consistently linked to feelings of shame. Guilt, unlike shame, has been identified as an activating emotion in motivation research (cf. activating emotions; Pekrun, 2006). Feelings of guilt have been associated with the controllability dimension, in that individuals tend to feel guilty after an experience for which they had personal control over the negative outcome of an event. Feelings of hopelessness have been linked to failure experiences for which an individual perceives the cause as stable, whereas hopefulness has been associated with perceived causes of failure that are unstable (Weiner, 1985). For example, a student who believes he or she failed a test due to a lack of ability (where ability is believed to be unchanging; cf. incremental vs. fixed theories of intelligence, (Dweck & Master, 2009) will likely experience feelings of hopelessness with regards to future tests. However, a student who believes that his or her failing grade on a test was due to a lack of familiarity, which tends to increase over time, is likely to be hopeful with respect to the next test.

## Previous Research

**Academic attributions.** Despite the plethora of empirical research supporting Weiner's Attribution Theory in academic contexts for K-12 students over the past 30 years, much of the research on Attribution Theory has been done with higher education students. Similar to K-12 research, attributions that are controllable and unstable have proven to be most beneficial for university students' motivation, persistence, and achievement. Attributions to effort have also been identified as highly important to achievement outcomes in this demographic. University level students who have been encouraged to make attributions to effort following failure outcomes have consistently received higher course grades and GPAs, and to have lower course and university attrition rates (Haynes, Perry, Stupnisky, & Daniels, 2009).

One of the first studies to examine the dimensions of causal attributions in a real life academic achievement setting was conducted by Van Overwalle (1989) in a study of 859 university freshmen from Belgium. In this four-part study, students ranked ten potential causes of midterm grades and dimensions of locus, stability, and controllability for each of the causes and overall, causes ranked in each dimension coincided with Weiner's Attribution Theory. Attributions examined included exam difficulty, ability, luck, interest in course material, effort, desire to do well on exams, help from others in preparing for exams, the professor's teaching method, study strategy, and previous knowledge of subject matter. Approximately 90% of students reported having control over effort and strategy.

An additional examination of university students' attributions provided further support for the validity of Attribution Theory in a real life academic achievement setting (Van Overwalle, Mervielde, & Schuyter, 1995). Two studies ($N_1 = 585$, $N_2 = 620$) of Belgian university freshmen revealed significant relationships between attributions, emotions, and

achievement. Findings showed midterm outcomes to predict attribution-independent emotions (i.e., happiness, sadness) and internal attributions to predict emotions related to self-esteem (i.e., pride, shame). Stable attributions were related to expectations and anticipatory emotions (hope, despair, anxiety). Additionally, personally controllable attributions positively predicted guilt.

Concerning the effects of realistic attributions compared to non-realistic attributions on university student achievement, students who were encouraged to make realistic attributions have been found to spend more time on tasks for which they had high ability compared to tasks for which they had low ability (Försterling & Morgenstern, 2002). In two studies of students from a German university ($N = 136$), students were given intelligence tests and provided with manipulated feedback that was either realistic or non-realistic concerning their performance, as well as the average performance for the other participants. Participants in the realistic feedback group were provided with the number of items correctly answered on the intelligence tests, whereas participants in the unrealistic feedback group were provided with the mirror image of their actual results. Students who received realistic feedback for the pre-test spent more time on tasks for which they had higher ability compared to lower ability on the post-test, whereas students who received unrealistic feedback for the pre-test spent more time on tasks for which they actually had lower ability compared to higher ability on the post-test based on judgments from the type of feedback received. Consequently, students who received appropriate feedback performed better compared to those who received incorrect feedback. For both realistically and unrealistically informed groups, effort attributions assessed prior to the receipt of feedback were negatively correlated with pre-test scores, indicating fewer predictions for a hypothetical failure being due to lack of effort.

In addition to the implications causal attributions have for academic achievement, the examination of precursors to causal search is of importance in understanding situations for which students will engage in causal search and to what degree. Consistent with Weiner's Attribution Theory, causal search for an academic outcome has been predicted by students' perceived unexpectedness, importance, and negative valence related to the outcome. In a recent longitudinal study by Stupnisky, Stewart, Daniels, and Perry (2011), 371 first-year Canadian university students answered a questionnaire including hypothetical and "in vivo" evaluations of precursors to causal search, expectations for exam grades, and amount of time spent in causal search. Results showed an interaction of unexpectedness and negative valence to predict the most causal search in hypothetical scenarios. Post-test "in vivo" measures showed similar results, with an additional interaction of importance and positive valence that was secondary in predicting causal search relative to the unexpectedness by negative valence interaction. Scenario and post-test results showed unexpectedness and importance to be more strongly related to causal search compared to pre-test results, which indicated negative valence as the strongest predictor of causal search, indicating that students' perceptions of an event were different before and after an exam occurred and that responses to hypothetical scenarios are more representative of responses following an authentic event than anticipated reactions to the event.

Measures from the "in vivo" part of the study also showed students to view unexpected events as more negative and to change their reports of importance over time, so that higher grades were later seen as more important and lower grades were seen as less important. Similarly, student's perceptions of low grades were reported as less negative during the post-test questionnaire compared to original pre-test reports of how negative they thought a bad grade would be. For the hypothetical scenarios, negative valence, unexpectedness, and importance had

significant, positive correlations with causal search. Regression analyses for post-test results revealed the combination of unexpected and negative events to significantly predict causal search, and the interaction for importance by valence showed that students who viewed an event as less important and negative engaged in more causal search compared to students who viewed an event as less important but positive. Post-test results also showed important events to lead to causal search regardless of valence. Concerning the resulting causal attributions, causal search positively predicted attributions of ability, test difficulty, and luck, and negatively predicted effort attributions. With respect to emotions, causal search was positively correlated with shame and negatively correlated with pride. Finally, causal search was negatively related to final course percentage.

Weiner's Attribution Theory has been strongly supported by empirical findings in academic contexts for students in higher education age groups. The influence of an individual's perceived causes for academic outcomes on subsequent emotions and actions has consistently proven to be an important indicator of learning, academic achievement and attrition. Adaptive attributions have been identified as those that are personally controllable and unstable (i.e., effort), whereas attributions that are uncontrollable and stable (i.e., ability) have been identified as maladaptive in academic contexts. Additionally, students have been found to engage in causal search for academic outcomes in situations that are negative, unexpected, and important. Despite research regarding computer usage and problems, there exists a lack of research addressing responses to difficulties encountered during computing in academic contexts. Given the increasingly prevalent nature of technology requirements in higher education, increasing prevalence of technology-related challenges for students is to be expected, warranting a greater

focus on motivation constructs that address cognitive and emotional responses to negative outcomes in academic settings (e.g., attribution theory).

**Attributions toward computers.** In the domain of computer technology, there exists a body of research that applies Attribution Theory to judgments of computing technology by university students. Research on attributions made to computer technologies by students is minimal, however, significant effects have been found that indicate relevance of Attribution Theory applied to students' experiences with computer technologies including self-evaluations and beliefs regarding the social role of computer technology (Johnson, Marakas, & Palmer, 2006). Social cues (e.g., supportive comments, animated actions, intelligent responses to input) provided by computer program interfaces have been found to influence students' attributions of responsibility for the computer program in relation to satisfaction and outcomes regarding program use (Johnson, Veltri, & Hornik, 2008). In their examination of 391 university students from an introductory information systems course, Johnson et al. found that students who received a high number of cues made more external attributions toward computers (holding the computer responsible for outcomes of program use) compared to students who received a lower number of social cues. In other words, the extent to which students reported human characteristics in computers (i.e., being smart) contributed to external social attributions of responsibility. This study of also revealed females to make more external social attributions to computers compared to males.

The use of self-serving bias in human-computer interaction when working with computer interface programs (i.e., tips and tutorials) has also been explored in relation to university students' attributions toward computer technologies. A study of 202 undergraduate and graduate students showed students to typically make external attributions for successful computer tasks

and internal attributions for failure experiences (Serenko, 2007). Since these findings were contradictory to traditional relationships of a self-serving bias where external attributions have been related to failure experiences and internal attributions related to successes, further research is recommended to identify domain-specific relationships relevant to Attribution Theory. The influence of attributions toward computer technologies in academic contexts is underexplored but could be important in the development of learning software interfaces.

**General research on technology-related attributions.** Considering the implications of attributions for learning and the extent to which technology is currently integrated with education, research regarding technology-related attributions in academic contexts has begun to emerge in the field of educational psychology. Although there is little research that has examined Weiner's Attribution Theory in relation to university students' attributions for experiences with technologies used for learning purposes, a few studies have found significant relationships with learning and achievement.

Compared to a few empirical research studies focused on students in grades K-12, there are more recent studies that focus on technology-related attributions made by university students. Some early research in this domain has found computer-related failure attributions to predict enrolment in computer courses. In a study of 195 freshman and sophomore students, Campbell (1992) examined the effects of perceived computer usefulness, attributions and attitudes on enrolment in college computer courses and found significant positive correlations of attributions to ability and task difficulty with computer anxiety. Support for the application of Attribution Theory in the computer domain has also been provided in the study attributions and locus of control relevant to successful and unsuccessful web searches. Exploratory research by Mansourian and Ford (2007) in computer attributions has identified primary attributions to

learning strategy, lack of study, and lack of practice in the domain of computer learning. Additionally, university students have cited practice as a necessity in computer programming in response to open-ended questions regarding the cause for computer programming course performance, providing qualitative support for domain-specific attributions (Hawi, 2010). Computer attributions have also been linked to gendered stereotypes in recent experimental studies examining computer-related motivation. One study by Koch, Müller, and Sieverding (2008) of 86 German students aged 16-21 that included a manipulated USB failure found women to make more internal attributions and men to make more external attributions for the event, particularly when primed with a negative stereotype regarding women's computer competence. Although there were no significant gender differences in attributions for the positive stereotype or control groups, females did report less computer use, self-efficacy, intrinsic motivation, and knowledge than males, confirming a gender gap in computer competence for German college students (Koch et al.). Students who reported more computer knowledge were also found to make significantly more external attributions than students with less computer knowledge, indicating a link between computer experience and attributions.

A similar study of 206 German university students that examined interpersonal attributions (i.e., attributions made by individuals for events that happen to others) for the successful completion of a computer task by another individual (i.e., in a video presentation) found evidence of negative stereotypes for women and computer use in women's self-evaluations but not in their expectations of others (Sieverding & Koch, 2009). There were no gender differences observed in expectations, judgments of computer competence, or attributions made for the successful performance of a male or female in a video. However, women reported lower computer self-efficacy than men in when evaluating their own performance. Women also

reported that they would do worse than the person in the video, a result that was amplified when women were comparing themselves to a male video target. Attributions were not further explored in this study since there were no significant differences in attributions given to the success of males compared to females shown in the video.

In addition to gender stereotypes, computer-related attributions have also been examined in relation to other motivational constructs linked to achievement. For example, females have been found to make more maladaptive attributions for hypothetical scenarios of computer failures compared to their male counterparts in a sample of 200 German university students (Dickhäuser & Stiensmeier-Pelster, 2002). Findings with 600 undergraduate students from introductory courses in management information systems further showed attributional style (attributions made for hypothetical scenarios) to influence computer self-efficacy and causal attributions, which together impacted affective states, performance expectations, and exam performance (Rozell & Gardner III, 2000). Path analyses revealed internal attributions to predict positive affect concerning computer-related performance, and locus of control to positively predict exam performance but not GPA. Higher levels of effort and unstable attributions were also found to predict expectations of higher performance on future exams. An optimistic attributional style was linked with more internal attributions, whereas a pessimistic attributional style predicted lower levels of computer self-efficacy. Additionally, findings showed positive relationships between external attributions and computer experience, as well as between stable attributions and exam performance, with internal attributions found to predict more self-reported effort and positive mood.

Although significant findings of computer-related attributions have provided adequate support for the application of Attribution Theory in the computer domain, research specific to

computer attributions in achievement settings is sorely lacking. There are also several limitations to previous studies that warrant further research. For example, many of the findings presented were based on responses to hypothetical scenarios (Dickhäuser & Stiensmeier-Pelster, 2002) and the measurement of attributions often excluded the controllability dimension (Koch et al., 2008). Further, since gender differences were the focus in many of the aforementioned studies, measures for causal attributions were limited and often combined multiple attributions into a single item (i.e., ability vs. luck; Sieverding & Koch, 2009). Future research that includes more comprehensive measures of causal attributions relevant to technology-mediated academic contexts is necessary in understanding relationships with other motivation constructs and implications for learning and achievement.

## Present Study

To provide a more comprehensive understanding of how university students' causal attributions influence emotions in technology-mediated academic contexts, the present research assessed the relationships between attributions and emotions specific to academic computing problems in experimentally manipulated situations as well as with hypothetical scenarios. The present assessment of attributions for computer problems rather than grades, as well as assessment of the effects of multiple causal attribution dimensions on several emotions, expands upon previous research on the effects of causal attributions on emotions in the domain of academic computing. Furthermore, given that Attribution Theory hypothesizes causal search as a necessary prerequisite to examine effects of causal attributions on emotions, the present research also examined the effects of causal attributions in relation to varying degrees of causal search. By examining causal dimensions of attributions in relation to achievement emotions in situations that vary in degree of expectedness and importance (causal search precursors), the present

research further aims to also identify the types of computing situations in which the influence of attributions on emotions is strongest as well as which attributions are optimal when university students are faced with technological difficulties.

Based on the literature reviewed, the following hypotheses concerning effects of causal attributions on emotions, and the nature of these effects for situations with varying degrees of causal search, were evaluated in the present study and were formulated in accordance with Weiner's Attribution Theory (1985, 2000, 2010). The proposed hypotheses were founded on prior research on causal attributions concerning achievement (Stupnisky et al., 2011; Van Overwalle, 1989; Wong & Weiner, 1981) to inform the application of Attribution Theory to computing within academic achievement settings, thus results may not directly coincide with previous findings related to achievement.

*Hypothesis 1*. Personally controllable attributions for technology-related problems should predict more positive and less negative emotions concerning educational technology use. The effects of personally controllable attributions should also be stronger in relation to the effects of other attributions as per empirical research that suggests perceived controllability to be the most important predictor of individuals' attributions and emotions (Haynes et al., 2009).

*Hypothesis 2.* External attributions for technology-related problems should predict less positive and more negative emotions concerning educational technology use.

*Hypothesis 3.* Stable attributions for technology-related problems should predict less positive and more negative emotions concerning educational technology use, secondary to the effects of controllable attributions.

*Hypothesis 4.* The aforementioned effects of causal attributions should be most evident following scenario and experimental conditions that elicit more causal search than the minimum,

with the most causal search eliciting condition having a technological failure that is *unexpected* and *important*, as per Weiner's Attribution Theory in which it is suggested that negative, unexpected, and important events elicit the most causal search. Conversely, the emotional effects of causal attributions should be least evident in conditions eliciting the least amount of causal search, namely those in which the scenario or experimental technological failure is *expected* and *unimportant*.

**Overall Procedures**

The present research investigated the interactive effects of technology-related attributions and challenges on university students' technology-related emotions. More specifically, two studies were conducted to see if the cause to which individuals attribute computer-related problems influences their emotions and, if so, what specific attributions are optimal for dealing with technological challenges experienced during academic tasks. Upon beginning the survey, participants were randomly assigned to one of two studies. In the first study, participants read one of four randomly assigned *hypothetical scenarios* concerning technological challenges in academic situations. In the second study, participants were randomly assigned to one of four *experimental simulation conditions* in which a technological challenge of varying intensity was simulated. Methodologies, results, and discussions for the each of the two studies are outlined separately below.

Students interested in participating in a web-based study on perceptions regarding academic computing were provided a link to the study midway through the Winter 2014 term. Students were first presented with the consent form (see Appendix A) on which they indicated their consent by providing identifying information and clicking 'Next' to begin the study. Participants were also provided with contact information for the researchers and encouraged to

contact the researchers with any questions prior to beginning the study. Participants then proceeded to the questionnaire, with the questionnaire consisting of demographics items (e.g., age, gender, computing experience) as well as attribution and emotion measures specific to using technology for educational purposes (see Appendix B).

## Scenario Study

### Methods.

***Participants.*** The scenario study sample consisted of 167 undergraduate students from McGill University who were recruited via in-class announcements during the Winter 2014 term. Participants' mean age was 20.16 years ($SD$ = 2.07) and 74.70% were female. Participants' average self-reported final high school grade was 88.41% ($SD$ = 6.04) and 70.70% spoke English as a first language. The participant sample was comprised of 29.50% first year, 38% second year, 21.10% third year, 10.80% fourth year, and 0.60% fifth year or above undergraduates. Faculty affiliation for participants was as follows: 36.50% in arts, 30.50% in science, 21% in education, 9.60% in other disciplines, and 2.40% were registered for a Bachelor of arts and sciences. Participant attrition was observed with respect to missing data on the emotion items reducing the sample size by 13.80% ($N$ = 144) where there were 37 students in the unexpected/high importance group, 33 students in the unexpected/low importance group, 38 students in the expected/high importance group, and 36 students in the expected/low importance group. Missing data analyses did not reveal any patterns in missing data. Participants were provided an opportunity to enter a draw for one of two cash prizes of $250 in exchange for their participation.

***Procedures.*** After completing the demographic and attribution measures, participants were asked to read a hypothetical scenario concerning a technological difficulty encountered in an academic setting. Participants were randomly assigned to read one of four hypothetical

scenarios (shown below) and completed measures of attribution-related emotions specific to the scenario presented. At the conclusion of the study, participants were asked to provide comments and feedback, and were then presented with a debriefing form (see Appendix D) regarding the intent and nature of the study. Overall, the questionnaire took approximately 20 minutes to complete.

*Hypothetical Scenarios*

In each of the scenario conditions, participants were asked to read a vignette involving a computer problem and imagine they were experiencing the event. Participants were then asked to answer the subsequent emotion measures in which they anticipated their emotional reactions had they experienced the hypothetical scenario. The following four hypothetical scenarios were based on the expected vs. unexpected and important vs. unimportant dimensions of causal search (Weiner, 1985; Stupnisky et al., 2011). Expectedness and importance have been shown to have more significant main effects than valence (positive vs. negative) in determining the extent to which individuals engage in causal search following a hypothetical or actual academic failure event (Stupnisky et al.). As such, the dimensions of expectedness and importance were evaluated specifically concerning a failure event in order to more directly analyze the effects of these key dimensions on the relationship between attributions and emotions.

*Scenario Conditions*

*1. Expected/High Importance.* "You have just finished a project for class and the program you are using suddenly crashes. A copy of your work was not saved. This is expected because you have had the same problem with this program before. This project is worth 40% your final grade and you will have to redo your work before the deadline."

*2. Expected/Low Importance.* "You have just finished a project for class and the program you are using suddenly crashes. A copy of your work was not saved. This is expected because you have had the same problem with this program before. This project is worth 5% your final grade and you will have to redo your work before the deadline."

*3. Unexpected/High Importance.* "You have just finished a project for class and the program you are using suddenly crashes. A copy of your work was not saved. This is unexpected because you have never had this problem with this program before. This project is worth 40% your final grade and you will have to redo your work before the deadline."

*4. Unexpected/Low Importance.* "You have just finished a project for class and the program you are using suddenly crashes. A copy of your work was not saved. This is unexpected because you have never had this problem with this program before. This project is worth 5% your final grade and you will have to redo your work before the deadline."

***Independent measures.***

*Attributions.* Causal attributions were assessed using the Revised Causal Dimension Scale (CDSII), which consisted of twelve 9-point items measuring perceived locus of causality, personal control, stability, and external control (McAuley, Duncan, & Russell, 1992) modified for academic computing-related failure events. Minor adjustments were also made to the item wordings to reflect first-person phrasings (i.e., "yourself" was changed to "myself"). Participants were asked to first indicate a primary cause for a computer problem experienced in the past and then to rate the identified cause on each item of the CDSII. Each causal dimension was evaluated with three items namely locus of causality (e.g., 1 = "The cause reflects an aspects of the situation"; 9 = "The cause reflects an aspect of myself"), personal control (e.g., 1 = "The cause is something over which I have no power"; 9 = "The cause is something over which I have

power"), stability (e.g., 1 = "The cause is temporary"; 9 = "The cause is permanent"), and external control (e.g., 1 = "The cause is something other people cannot regulate"; 9 = "The cause is something other people can regulate"). Descriptive statistics for each of the four causal dimension scales are as follows: locus of causality (*M* = 9.92, *SD* = 5.74, Range = 3-27, α = .79), personal control (*M* = 14.08, *SD* = 8.05, Range = 3-27, α = .91), stability (*M* = 10.83, *SD* = 5.80, Range = 3-27, α = .54), external control (*M* = 11.22, *SD* = 6.55, Range = 3-27, α = .77). Internal reliabilities for the attribution measures were satisfactory, with the exception of poor reliability for the stability dimension.

*Computer experience and usage.* Background computing measures included average hours used per week specific to academics (*M* = 24.42, *SD* = 16.59, Range = 2-90) and recreation (*M* = 16.82, *SD* = 11.70, Range = 0-70), as well as total hours (*M* = 41.58, *SD* = 20.69, Range = 8-120). Computer experience in relation to others (1 = *none*, 5 = *excellent*; *M* = 3.96, *SD* = .73, Range = 2-5), number of different computer devices used per week (*M* = 2.32, *SD* = .70, Range = 1-4), and the type of device used to complete the study (laptop = 75.40%, desktop = 8.40%, smart phone = 3%, tablet = 0.60%) were also used to assess computing experience and usage.

***Dependent measures.***

*Attribution-related emotions.* Thirteen ten-point items (1 = *not at all*, 10 = *very much so*) were used to measure attribution-based emotions concerning hypothetical scenarios, as derived from parallel items previously used to measure emotions concerning academic performance (Hall et al., 2007; Hall, Jackson, Goetz, & Musu-Gillette, 2011). The emotion items derived specifically from Attribution Theory consisted of hope (*M* = 2.68, *SD* = 2.30, Range = 1-10), guilt (*M* = 4.54, *SD* = 3.21, Range = 1-10), helplessness (*M* = 6.44, *SD* = 2.85, Range = 1-10), pride (*M* = 1.42, *SD* = 1.63, Range = 1-10), anger (*M* = 7.44, *SD* = 2.61, Range = 1-10), and

shame ($M$ = 3.73, $SD$ = 2.90, Range = 1-10). To clarify the directionality of anger assessed in Attribution Theory, anger was assessed directly in relation to anger at oneself ("angry at myself"). Due to significant relationships between perceptions of control and achievement emotions previously established in the Control-Value Theory literature (Pekrun, 2006), similarly scaled items for boredom ($M$ = 2.11, $SD$ = 2.21, Range = 1-10), anxiety ($M$ = 7.88, $SD$ = 2.55, Range = 1-10), relief ($M$ = 1.08, $SD$ = .62, Range = 1-8), and enjoyment ($M$ = 1.07, $SD$ = .60, Range = 1-8) were also included.

**Results.**

***Preliminary analyses.***

*Initial differences.* Independent-samples t-tests were conducted to determine if there were initial differences between background variables and study measures. There was a significant initial difference between males and females on helplessness [$t(141) = 2.21$, $p < .05$]. An examination of means revealed females to have significantly more feelings of helplessness ($M$ = 6.77, $SD$ = 2.77) compared to males ($M$ = 5.57, $SD$ = 2.84). There was also a marginally significant initial difference between males and females on anxiety [$t(140) = 1.87$, $p = .06$], with females having more feelings of anxiety ($M$ = 8.12, $SD$ = 2.42) compared to males ($M$ = 7.20, $SD$ = 2.85). Analyses of variance (ANOVAs) did not reveal any initial differences in attributions or background computer use measures between participants in the scenario conditions.

*Correlational analyses.* Correlations between all continuous study variables are presented in Table 2. As expected, there were several significant relationships between the emotion items that showed positive emotions to be positively correlated with each other (i.e., pride and enjoyment) and negative emotions to be positively correlated with each other (i.e., anxiety and

Table 2

*Zero-Order Correlations Among Scenario Study Variables and Covariates*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Internal attributions | - | | | | | | | | | | | | | |
| 2. Personally controllable attributions | .64*** | - | | | | | | | | | | | | |
| 3. Stable attributions | .07 | -.04 | - | | | | | | | | | | | |
| 4. External attributions | -.01 | .02 | .02 | - | | | | | | | | | | |
| 5. Hope | -.02 | .14 | -.12 | .01 | - | | | | | | | | | |
| 6. Guilt | .00 | -.07 | .19* | .14 | .01 | - | | | | | | | | |
| 7. Helplessness | -.19* | -.22** | .14 | .18* | -.27*** | .22** | - | | | | | | | |
| 8. Pride | -.11 | -.14 | -.11 | .00 | .12 | .20* | .15 | - | | | | | | |
| 9. Anger | .11 | .08 | -.06 | .07 | -.17* | .32*** | .12 | -.01 | - | | | | | |
| 10. Shame | .05 | -.01 | .16* | .11 | -.16 | .43*** | .17* | .19* | .32*** | - | | | | |
| 11. Boredom | -.05 | .05 | .12 | .06 | .03 | .18* | .07 | .11 | .08 | .20* | - | | | |
| 12. Anxiety | -.03 | -.17* | .02 | .06 | -.31*** | .12 | .38*** | .08 | .24** | .24** | .00 | - | | |
| 13. Relief | -.02 | -.07 | .09 | -.05 | .25** | .07 | .00 | .32*** | -.04 | .10 | .23** | -.03 | - | |
| 14. Enjoyment | .00 | -.04 | .10 | -.02 | .19* | .08 | .03 | .33*** | .03 | .13 | .21* | .02 | .97*** | - |
| Covariates | | | | | | | | | | | | | | |
| 15. Hours of computer use per week | .02 | .04 | .07 | .03 | .01 | .09 | .07 | .05 | .23** | .24** | .06 | .05 | .02 | .01 |
| 16. Number of devices used per week | -.08 | -.02 | -.12 | .01 | -.06 | .07 | .05 | -.20* | .06 | .04 | -.12 | .05 | -.16 | -.14 |

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

helplessness). Positive emotions also had significant and negative relationships with negative emotions (i.e., hope and helplessness). In accordance with Weiner's Attribution Theory (1985), personally controllable attributions were negatively related to feelings of helplessness and external attributions were positively related to feelings of helplessness. Personally controllable attributions were also negatively related to feelings of anger and anxiety, and stable attributions were positively related to feelings of guilt and shame. Additionally, there was a strong correlation between internal and personally controllable attributions, which was not surprising considering similar findings from recent research utilizing the CDSII (Wang & Hall, 2014). Interestingly, hours of computer use per week positively correlated with anger and shame. The average number of devices used per week was also negatively related to feelings of pride.

***Rationale for main analyses.*** The hypothesized first-order effects (attributions on emotions) and interaction effects (attributions by scenario conditions on emotions) were evaluated in the current study using linear regression analyses with the covariates including gender, average hours of computer use per week, and average number of devices used per week based on results of the preliminary analyses. Covariates were also chosen in accordance with previous literature showing significant relationships between computer attitudes and gender (Cooper, 2006), as well as computer use and experience (Havelka et al., 2004; McIlroy et al., 2007). Due to the high correlation between emotions of enjoyment and relief ($r$ = .97), relief was not examined in the main analyses to avoid issues of multicollinearity. All together, emotion items assessed in the main analyses consisted of hope, guilt, helplessness, pride, anger, shame, boredom, anxiety, and enjoyment.

Hypothesized effects were tested using hierarchical regressions with mean-centered predictors. In all regression analyses, Step 1 included the background variables of gender,

average hours of computer use per week, and average number of devices used per week. To evaluate the study hypotheses, variables representing the scenario conditions, attributions, and condition by attribution interaction terms were included in Step 2. In order to evaluate the causal dimensions of attributions independently, and to preserve statistical power, regressions for each of the four attribution dimensions (internality, personal controllability, stability, and externality) were evaluated as separate regression analyses. Scenario conditions were dummy coded with the expected/low importance group as the reference group based on Attribution Theory that assumes events that are expected and unimportant to elicit less causal search in comparison to events that are unexpected or important.

***Main analyses.***

*First-order effects.* Significant first-order effects showed the expected/high importance scenario to predict feelings of pride (βs = .21-.26, *p*s ≤ .01-.05), shame (βs = .26-.30, *p*s ≤ .01), and anxiety (βs = .36-.39, *p*s ≤ .001). The unexpected/high importance scenario was also found to predict feelings of anxiety (βs = .29-.35, *p*s ≤ .01-.001). An examination of means showed students in the expected/high importance condition to have higher pride and shame ($M = 2.11$, $SD = 2.83$; $M = 4.81$, $SD = 2.99$, respectively) compared to the unexpected/high importance condition ($M = 1.11$, $SD = 0.39$; $M = 3.62$, $SD = 2.71$, respectively), unexpected/low importance condition ($M = 1.21$, $SD = 0.74$; $M = 3.28$, $SD = 3.00$, respectively), and expected/low importance condition ($M = 1.22$, $SD = 1.02$; $M = 3.14$, $SD = 2.73$, respectively). Students in the expected/high importance ($M = 8.92$, $SD = 1.30$) and unexpected/high importance ($M = 8.49$, $SD = 2.38$) groups were also found to have higher anxiety compared to the unexpected/low importance ($M = 7.30$, $SD = 2.34$) and expected/low importance ($M = 6.72$, $SD = 3.26$) groups. Additionally, significant first-order effects were found in which internal attributions predicted

higher anger (β = .32, $p < .05$) and external attributions predicted greater anxiety (β = .32, $p = .05$). Results showing external attributions to predict negative emotions (i.e., anxiety) were consistent with Hypotheses 2. Internal attributions did not predict emotions in a manner consistent with Attribution Theory, however, the effects of internal attributions on emotions as stated in Hypothesis 2 were anticipated to be confounded due to the fact that internal attributions possess properties of personal control. As such, internal attributions can be either personally controllable (i.e., ability) or personally uncontrollable (i.e., effort). In accordance with Hypothesis 1, there was also a first-order effect that approached significance ($p = .17$ for the overall model) showing personally controllable attributions to predict hope (β = .39, $p = .01$). Hierarchical regression results for internal, personally controllable, stable, and external attributions are presented in Table 3.

*Higher-order effects.* Significant interactions between stable attributions and the unexpected/low importance condition on helplessness (Figure 3), boredom (Figure 4), and anxiety (Figure 5) were also observed. Stable attributions were found to significantly predict feelings of helplessness (β = .23, $p = .05$), boredom (β = .41, $p = .001$), and anxiety (β = .23, $p = .05$) only for those in the unexpected/low importance group. Additionally, a significant interaction between external attributions and the unexpected/high importance scenario on anxiety was found (β = -.27, $p < .05$), with external attributions predicting lower anxiety only for students in the unexpected/high importance scenario group (Figure 6). Consistent with Hypothesis 3, stable attributions were found to predict more negative emotions (i.e., helplessness). Contrary to the anticipated results specified in Hypothesis 2, external attributions were found to predict less rather than more negative emotions (i.e., anxiety). In Hypothesis 4, benefits of personally controllable attributions were anticipated to be most evident in the

Table 3

*Scenario Study Hierarchical Regression Results by Attributions*

| Predictor | Hope | Guilt | Helplessness | Pride | Anger | Shame | Boredom | Anxiety | Enjoyment |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Internal attributions | | | | |
| Step 1 | | | | | | | | | |
| Gender | -.10 | .13 | .17* | .07 | .08 | -.06 | -.08 | .16 | .03 |
| Computer use | .03 | .07 | .05 | .04 | .22** | .24** | .07 | .04 | .02 |
| Devices used | -.06 | .06 | .04 | -.20* | .06 | .03 | -.11 | .05 | -.13 |
| $R^2$ | .01 | .03 | .03 | .05 | .06* | .06* | .02 | .03 | .02 |
| Step 2 | | | | | | | | | |
| Internal attributions (In) | -.09 | .13 | -.17 | -.15 | .32* | .19 | -.11 | -.13 | .00 |
| Unexpected/High importance (U/H) | -.22* | .01 | .18 | -.03 | .07 | .07 | -.01 | .32** | .02 |
| Unexpected/Low importance (U/L) | -.11 | -.04 | -.07 | -.02 | -.09 | -.01 | .05 | .10 | -.01 |
| Expected/High importance (E/H) | -.24* | .13 | .00 | .24* | .16 | .28** | .05 | .38*** | .16 |
| In X U/H | .11 | .00 | .09 | .08 | -.12 | -.08 | -.05 | .09 | -.01 |
| In X U/L | .03 | -.11 | -.13 | .03 | -.13 | -.16 | -.07 | -.01 | -.01 |
| In X E/H | .01 | -.10 | .01 | -.05 | -.19 | -.13 | .11 | .10 | -.01 |
| $R^2$ | .07 | .06 | .12 | .14* | .13* | .14* | .06 | .16** | .04 |

See *Note* at the bottom of Table 3. *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Table 3 *(continued)*

*Scenario Study Hierarchical Regression Results by Attributions*

| Predictor | Hope | Guilt | Helplessness | Pride | Anger | Shame | Boredom | Anxiety | Enjoyment |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Personally controllable attributions | | | | | |
| Step 2 | | | | | | | | | |
| Personally controllable attributions (Pc) | .39** | .07 | -.22 | -.13 | .16 | .02 | -.01 | -.28 | .01 |
| U/H | -.18 | .02 | .15 | -.04 | .08 | .05 | -.04 | .29** | .02 |
| U/L | -.07 | -.04 | -.08 | -.03 | -.06 | .00 | .06 | .09 | .01 |
| E/H | -.20* | .11 | -.04 | .21* | .17 | .26** | .05 | .36*** | .15 |
| Pc X U/H | -.09 | .01 | .02 | .09 | -.06 | .04 | -.02 | .09 | -.02 |
| Pc X U/L | -.23* | -.05 | -.07 | .04 | -.01 | .00 | .00 | .09 | .03 |
| Pc X E/H | -.21 | -.17 | .09 | -.12 | -.06 | -.08 | .10 | .15 | -.11 |
| $R^2$ | .10 | .07 | .12 | .15* | .11 | .13* | .04 | .16** | .05 |
| | | | | Stable attributions | | | | | |
| Step 2 | | | | | | | | | |
| Stable attributions (St) | -.09 | .09 | -.08 | -.03 | -.09 | .04 | -.14 | -.21 | -.02 |
| U/H | -.24* | .03 | .18 | -.03 | .08 | .06 | -.04 | .32*** | .02 |
| U/L | -.15 | -.04 | -.02 | -.02 | -.08 | -.01 | .09 | .13 | .01 |
| E/H | -.26** | .14 | .01 | .26** | .18 | .27** | .03 | .39*** | .14 |
| St X U/H | -.03 | .17 | .16 | -.04 | .09 | .16 | .04 | .07 | -.01 |
| St X U/L | -.15 | .10 | .23* | -.01 | .03 | .15 | .41*** | .23* | .00 |
| St X E/H | .08 | -.07 | .02 | .19 | -.09 | -.07 | .09 | .11 | .15 |
| $R^2$ | .12 | .12 | .13* | .16** | .13* | .19** | .15* | .18** | .06 |

See *Note* at the bottom of Table 3. *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Table 3 *(continued)*

*Scenario Study Hierarchical Regression Results by Attributions*

| Predictor | Hope | Guilt | Helplessness | Pride | Anger | Shame | Boredom | Anxiety | Enjoyment |
|---|---|---|---|---|---|---|---|---|---|
| | | | | External attributions | | | | | |
| Step 2 | | | | | | | | | |
| External attributions (Ex) | -.06 | -.08 | .23 | -.17 | -.01 | .24 | .17 | .32* | -.04 |
| U/H | -.24* | .03 | .18 | -.04 | .09 | .10 | -.05 | .35*** | .01 |
| U/L | -.14 | .03 | .00 | -.03 | -.03 | .05 | .08 | .14 | .01 |
| E/H | -.26** | .15 | .01 | .24* | .18 | .30** | .04 | .39*** | .16 |
| Ex X U/H | .10 | .13 | -.01 | .13 | -.01 | -.13 | .04 | -.27* | .07 |
| Ex X U/L | .05 | .27* | -.02 | .07 | .19 | -.04 | .01 | -.13 | .02 |
| Ex X E/H | .00 | .04 | -.06 | .15 | -.04 | -.12 | -.21 | -.16 | -.04 |
| $R^2$ | .08 | .11 | .11 | .13* | .13* | .14* | .08 | .19** | .05 |

*Note.* Step 1 values for the internal attribution analyses were highly similar to those for the personally controllable, stable, and external attribution analyses and are not presented. Standardized β coefficients and $R^2$ values are provided for regressions on study measures. Regression coefficient and $R^2$ values are for the step in which they were first entered. Significance of $R^2$ values indicates two-tailed significance of change from previous step. *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

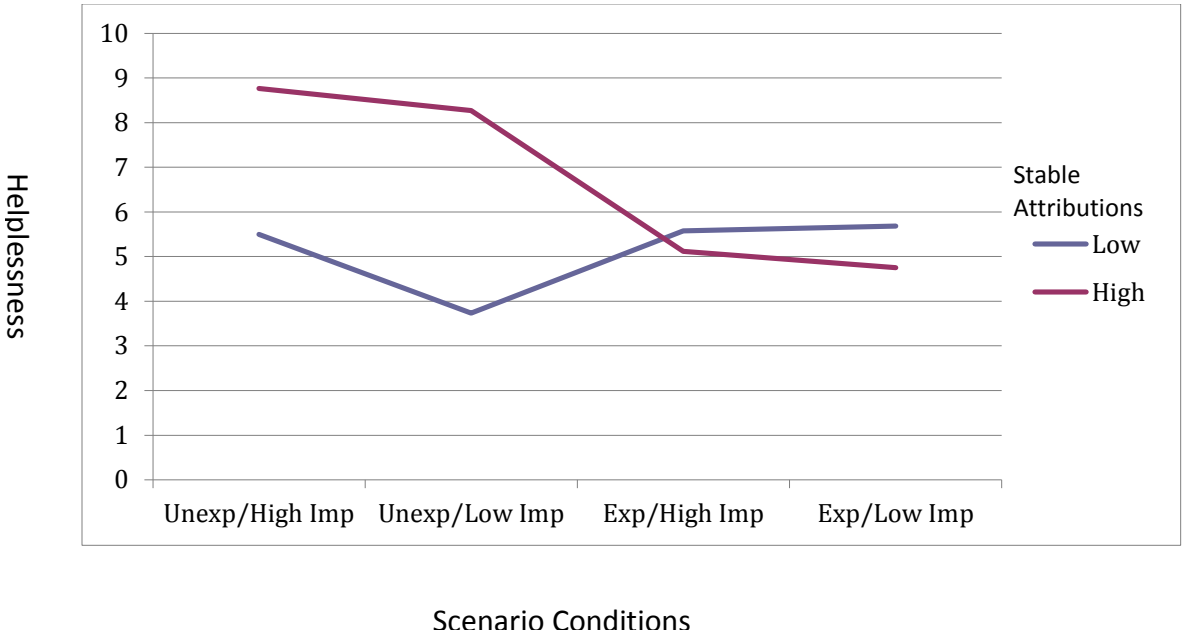


*Figure 3.* Effects of stable attributions by scenario conditions for feelings of helplessness.

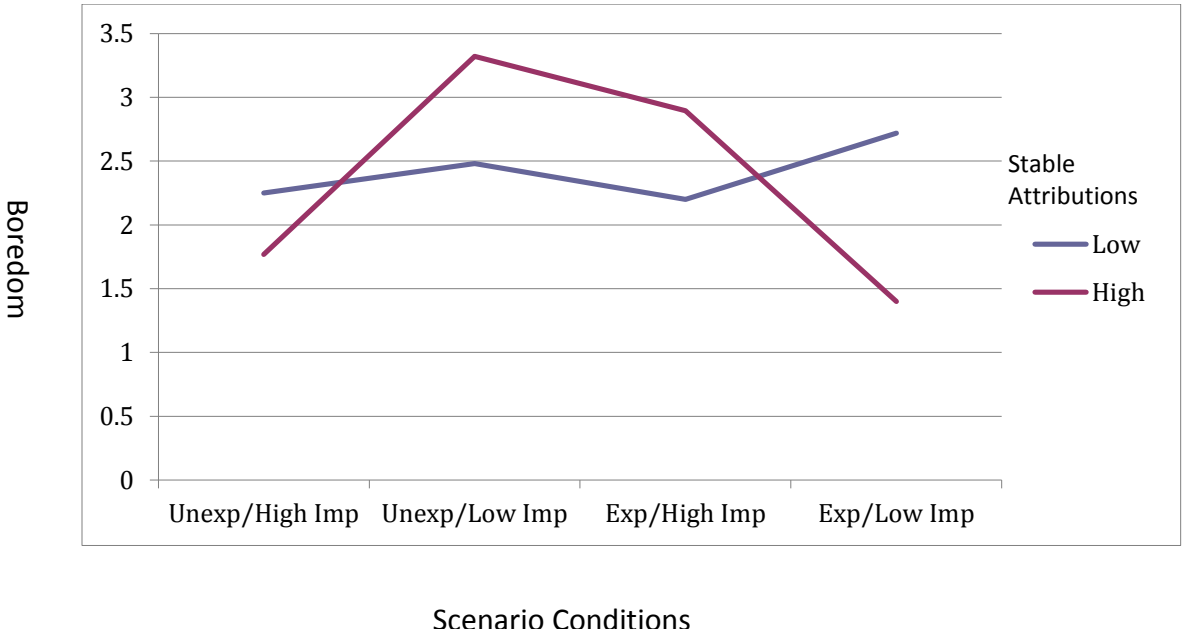


*Figure 4.* Effects of stable attributions by scenario conditions for feelings of boredom.

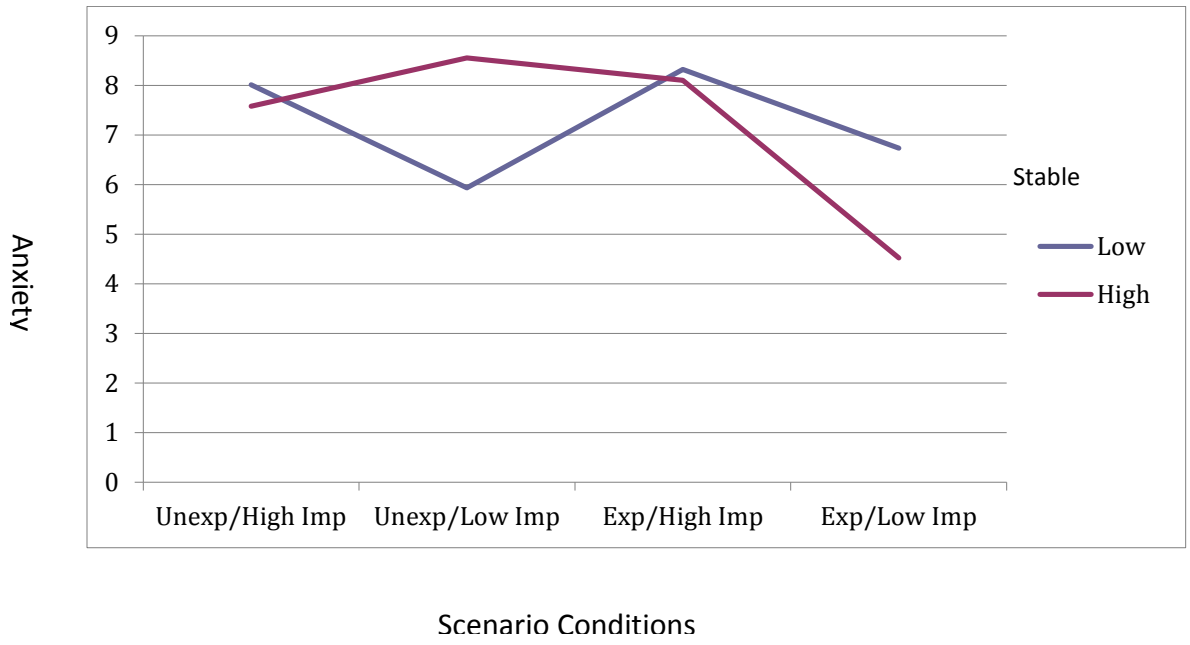


*Figure 5.* Effects of stable attributions by scenario conditions for feelings of anxiety.

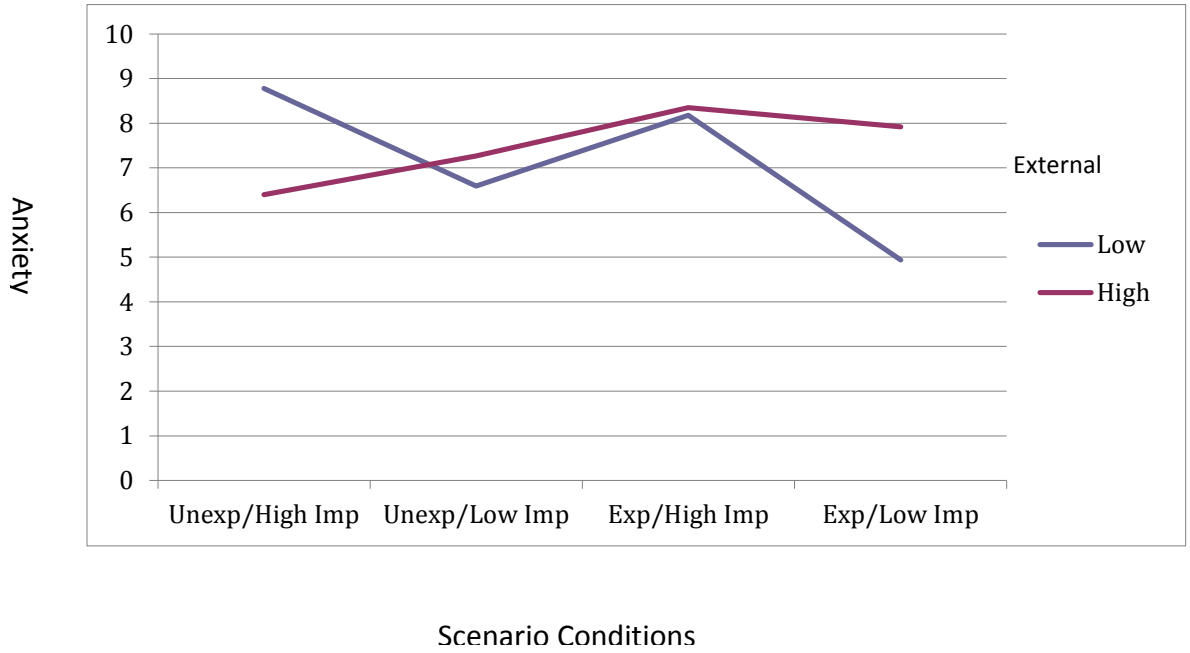


*Figure 6.* Effects of external attributions by scenario conditions for feelings of anxiety.

unexpected/high importance condition, however, unanticipated benefits of external attributions were most evident in this condition. No significant effects for personally controllable attributions were found.

**Discussion.**

***Hypotheses.*** As informed by Weiner's Attribution Theory (1985, 2000, 2010) and previous research on attributions for academic achievement, personally controllable attributions for technology-related problems were expected to predict more positive and less negative emotions concerning educational technology use (Hypothesis 1). As anticipated, personally controllable attributions were found to predict positive emotions (i.e., hope), however this finding is not further supported with effects for significant overall models. The lack of supplementary evidence for emotional benefits of personally controllable attributions following technological failure experiences indicates that findings observed concerning the effects of attributions for poor academic achievement do not directly correspond to those observed for attributions for computing difficulties as was anticipated.

As indicated in Hypothesis 2, external attributions for technology-related problems were expected to predict less positive and more negative emotions concerning educational technology use, whereas internal attributions were expected to predict more positive and less negative emotions according to traditional Attribution Theory. The observed first-order effects of external attributions were consistent with the expectations of Hypothesis 2, in that external attributions for technology-related problems were found to significantly predict anxiety for educational technology use. In accordance with anticipated confounds between internality and personal controllability, internal attributions were found to predict more negative emotions. Specifically, the present finding of internal attributions to predict feelings of anger is novel in that anger is

typically addressed as a social emotion rather a self-directed emotional experience in Weiner's Attribution Theory.

According to the third hypothesis, stable attributions for technology-related problems were expected to predict less positive and more negative emotions concerning educational technology use (but to a lesser degree than controllable attributions). Interaction effects involving stable attributions were found to partially support Hypothesis 3 in that stable attributions predicted helplessness, boredom, and anxiety for students who experienced a technological difficulty that was unexpected and of low importance. Effects of controllable attributions were anticipated to be stronger in relation to effects of stable attributions, however, a lack of effects for personally controllable attributions contradicted this aspect of the hypothesis.

The fourth hypothesis proposed that the emotional benefits and risks of causal attributions would be most evident following the scenario condition with technological problems that were unexpected and of high importance, whereas the emotion effects of attributions would be least evident in the condition with a technological failure that was expected and of low importance. Although no interaction effects involving personally controllable attributions were found, emotional disadvantages of stable attributions were observed for students who experienced a technological problem that was unexpected and of low importance, and emotional benefits of external attributions were observed for students who experienced a technological problem that was unexpected and of high importance (assumed to be the most impactful condition concerning causal search).

The observed interaction effects showing the emotional disadvantages of stable attributions to be most evident in the scenarios in which technological difficulties were unexpected are consistent with Attribution Theory in that causal search is assumed to be

strongest following events that are negative, unexpected, or important. Although these findings did not directly support the proposed hypotheses (that the unexpected/important condition should demonstrate the strongest attribution effects), prior research examining precursors to causal search has also found significant combined effects of negative and low importance events on causal search for university students with regard to academic performance, as well as similar effects of negative and unexpected events (Stupnisky et al., 2011; Wong & Weiner, 1981). Additionally, the significant effects of stable attributions support Weiner's assumption of unstable attributions to predict positive emotions due to the potential for future problems to change, in that students who made unstable attributions in situations anticipated to elicit more causal search had lower negative emotions compared to students who made stable attributions. In explaining the unexpected effects of external attributions in the unexpected/high importance condition on anxiety, external attributions in the academic computing domain may serve as a coping mechanism in mitigating the impact of causal search on self-directed emotions when technological difficulties arise (Koch et al., 2008).

***Limitations.*** With respect to the interpretation of results for the scenario study, there are several limitations to be considered. The use of hypothetical scenarios and the absence of baseline measures in the scenario study do not allow for definitive causal evidence regarding the relationships between precursors to causal search, attributions, and emotions. However, causal attributions have been previously assessed using hypothetical scenarios in relation to causal search (Stupnisky et al., 2011) and emotions (Weiner, 2003) in which results obtained have been consistent with Attribution Theory. Another limitation of the present study is the use of self-report data, which is susceptible to subjective bias without objective data, as well as single-item measures for the emotion items, which are more vulnerable to random measurement error

compared to composite scales. With respect to the use of single-item measures, recent research concerning motivational-affective constructs provides support for the psychometric validity of single-item measures when longer scales are not practical in educational research (Gogol et al., in press).

The observed effects of stable attributions should also be considered with caution due to the low reliability of the stability measure thus warranting further research validating the use of these newly developed scales with undergraduate students. Additionally, as the present study was conducted within a single time point, the present findings do not allow for speculation concerning the longitudinal effects of causal attributions, or the computing scenarios, on computing-related emotions over time. To further evaluate the replicability of the present findings, research that examines a larger sample of students from additional populations (i.e., online learning universities) is recommended.

***Implications and future directions.*** Overall, these findings demonstrate important effects of causal attributions on achievement-related emotions concerning the difficulties encountered during academic computing in higher education. The present findings suggest that encouraging students to make more external attributions for serious computer problems may be an effective intervention technique given that external attributions for academic computing difficulties were linked to fewer demotivating emotions (e.g., anxiety). However, this implication may be premature given considerable research on attribution-based interventions that clearly show encouraging controllable attributions for academic failure to be consistently beneficial for academic development (Hall, Hladkyj, Perry, & Ruthig, 2004; Hall et al., 2007, 2011). Thus, to the extent that findings were not consistent with Weiner's model or prior research on attributions for academic failure, future research in which these relations are replicated longitudinally is

warranted. The absence of significant results for positive motivating emotions also highlights the need for future research before programs to benefit students who encounter technological difficulties can be considered. Additionally, findings concerning stable attributions provide support for the encouragement of unstable attributions for moderately serious computer problems, which was suggested by early research in programs designed to promote more positively motivating attributions for academic performance (Wilson & Linville, 1982, 1985). However, the effects pertaining to stable attributions should be interpreted with caution due to low scale reliability, warranting further research on attributions and emotions in the academic computing domain to inform the development of technology support programs for university students.

## Experimental Study

### Methods.

***Participants.*** The experimental study sample consisted of 182 undergraduate students from McGill University who were recruited via in-class announcements during the Winter 2014 term. Participants' mean age was 20.60 years (*SD* = 2.66) and 73.10% were female. Participants' average self-reported final high school grade was 87.81% (*SD* = 6.12) and 55.50% spoke English as a first language. The participant sample was comprised of 31.30% first year, 31.30% second year, 21.40% third year, 13.70% fourth year, and 2.20% fifth year or above undergraduates. Faculty registration for participants was as follows: 37.50% in arts, 26.40% in science, 24.70% in education, 11.40% in other disciplines, and 1.60% were registered for a Bachelor of arts and sciences. Participants were provided an opportunity to enter a draw for one of two cash prizes of $250 in exchange for their participation.

Participant attrition was observed with respect to missing data on the emotion items reducing the sample size by 45.10% ($N = 100$). Following the simulated computer error, there were 28 students in the unexpected/high importance group, 21 students in the unexpected/low importance group, 27 students in the expected/high importance group, and 24 students in the expected/low importance group. Missing data analyses did not reveal any patterns in missing data, indicating participant attrition to be due to the believability of the experimental manipulation.

***Procedures.*** Just prior to the demographics items on the first questionnaire page, participants assigned to the experimental study were presented with a preamble (see Appendix B). The preamble either underscored the reliability of the survey method (problems were unexpected) or novelty of the survey method (problems could reasonably be expected). Following the subsequent attribution measures, participants in the experimental study were then asked to read an article and write either a short or long summary of the content. Following the summary page, participants were then presented with a manipulated error page indicating that an error had occurred and the text entered by the participant had been lost. This feedback was intended to simulate either an unimportant loss of text (one paragraph summary) or important loss of text (two paragraph summary). Therefore, the preamble content (expected vs. unexpected) combined with the amount of data lost (low importance vs. high importance) comprised the four conditions in this experimental simulation study (shown below). Participants were randomly assigned to one of the four conditions at the beginning of the study and after the simulated loss of text the emotion measures were evaluated. At the conclusion of the study, participants were asked to provide comments and feedback, and were then presented with a

debriefing form (see Appendix D) regarding the intent and nature of the study, as well as the deception employed. Overall, the questionnaire took approximately 30 minutes to complete.

*Experimental Simulation*

Each of the four experimental simulation conditions represents a combination of expected vs. unexpected and important vs. unimportant event characteristics similar to those in the scenario study to evaluate these two important dimensions of causal search outlined in Weiner's Attribution Theory (1985). As outlined above, participants were presented with a preamble on the first page of the study priming them to either expect or not expect a system error, and after the subsequent demographic and causal attribution questions, were presented with a manipulated failure event that was either of high importance or low importance as determined by the amount of text that was lost (one paragraph vs. two paragraphs). The experimental conditions were based on evidence that time lost during computing tasks due to errors has the strongest relationship with frustration as compared to other time-related variables such as computer anxiety, computer-related self-efficacy, and mood (Lazar, Jones, Hackley, & Shneirderman, 2006). Additionally, error messages have been identified as the most experienced cause of computer-related frustration in student samples (Ceaparu, Lazar, Bessiere, Robinson, & Shneiderman, 2004).

*Experimental Conditions*

*1. Expected/High Importance.* In the first experimental condition, participants read the following preamble prior to beginning the survey: "Thank you for your participation in this study. Please note that some participants have experienced technical difficulties with the study website. If you encounter any problems while completing the study, please let us know on the comments page at the end of the study." After completing the causal attribution measures, participants were asked to read a short article (see Appendix C) and then type two paragraphs

(about five sentences each) in which they summarize and discuss the article on the subsequent response page. After participants clicked “Save and Continue" on the response page, the following page presented an error message stating that the response was not saved. Participants were asked to contact the researcher using the contact information provided at the end of the study and click “Continue” to complete the remaining questions. Participants were then directed to the final questionnaire pages that included the emotion measures.

*2. Expected/Low Importance.* In the second experimental condition, participants read the same preamble prior to beginning the survey as in Condition 1 (error expected). After completing the causal attribution measures, participants were asked to read the same article from the previous condition and type only one paragraph (about five sentences) in which they summarize and discuss the article. After participants clicked “Save and Continue" on the response page, the following page again presented an error message stating that the response could not be saved. Participants were asked to contact the researcher using the contact information provided at the end of the study and click “Continue” to complete the remaining questions. Participants were then directed to the final questionnaire pages that included the emotion measures.

*3. Unexpected/High Importance.* In the third experimental condition, participants read the following preamble prior to beginning the survey: “Thank you for your participation in this study. Please feel free to provide any feedback on the comments page at the end of the study.” Participants in this condition then reviewed the reading, wrote two paragraphs, received an error message, and completed the remaining emotion questions as outlined for Condition 1.

*4. Unexpected/Low Importance.* In the fourth experimental condition, participants read the same preamble as in Condition 3 prior to beginning the survey. However, the remainder of

the condition replicated the procedures outlined for Condition 2 including the reading, a one-paragraph writing task, an error message, and the final emotion measures.

***Independent measures.***

*Attributions.* Causal attributions were assessed using the Revised Causal Dimension Scale (CDSII), which consisted of the same twelve 9-point items measuring perceived locus of causality, personal control, stability, and external control as used in the scenario study (McAuley et al., 1992). Descriptive statistics for each of the four causal dimension scales are as follows: locus of causality ($M$ = 10.84, $SD$ = 6.18, Range = 3-27, α = .80), personal control ($M$ = 15.59, $SD$ = 7.18, Range = 3-27, α = .83), stability ($M$ = 9.86, $SD$ = 4.93, Range = 3-27, α = .41), external control ($M$ = 12.29, $SD$ = 6.81, Range = 3-27, α = .78). Internal reliabilities were satisfactory, with the exception of poor reliability for the stability dimension.

*Computer experience and usage.* Background computing measures included average hours used per week specific to academics ($M$ = 23.39, $SD$ = 14.88, Range = 0-90) and recreation ($M$ = 17.33, $SD$ = 14.96, Range = 1-110), as well as total hours ($M$ = 41.85, $SD$ = 21.91, Range = 5-130). Computer experience in relation to others (1 = *none*, 5 = *excellent*; $M$ = 3.71, $SD$ = .80, Range = 2-5), number of different computer devices used per week ($M$ = 2.40, $SD$ = .77, Range = 1-4), and the type of device used to complete the study (laptop = 45.60%, desktop = 5.50%, smart phone = 2.20%, tablet = 1.60%) were also used to assess computing experience and usage.

***Dependent measures.***

*Attribution-related emotions.* Thirteen ten-point items (1 = *not at all*, 10 = *very much so*) were used to measure attribution-based emotions concerning academic computer use, as derived from parallel items previously used to measure emotions concerning academic performance (Hall et al., 2007, 2011). The emotion items consisted of hope ($M$ = 4.37, $SD$ = 2.60, Range = 1-

9), guilt ($M$ = 3.09, $SD$ = 2.48, Range = 1-8), helplessness ($M$ = 4.46, $SD$ = 2.67, Range = 1-10), pride ($M$ = 3.19, $SD$ = 2.64, Range = 1-10), anger ($M$ = 3.33, $SD$ = 2.41, Range = 1-9), and shame ($M$ = 2.43, $SD$ = 2.12, Range = 1-8). To clarify the directionality of anger assessed in Attribution Theory, anger was assessed directly in relation to anger at oneself ("angry at myself"). Due to significant relationships between perceptions of control and achievement emotions previously established in the Control-Value Theory literature (Pekrun, 2006), items for boredom ($M$ = 3.08, $SD$ = 2.44, Range = 1-10), anxiety ($M$ = 4.44, $SD$ = 3.11, Range = 1-10), relief ($M$ = 2.86, $SD$ = 2.55, Range = 1-9), and enjoyment ($M$ = 3.00, $SD$ = 2.71, Range = 1-10) were also included.

**Results.**

***Preliminary analyses.***

*Initial differences.* Independent-samples t-tests were conducted to determine if there were initial differences between background variables and study measures. There were significant initial differences between males and females on emotions of helplessness [$t(66.48) = 4.35$, $p < .001$], shame [$t(96) = 4.11$, $p < .001$], and anxiety [$t(61.83) = 3.71$, $p < .001$]. An examination of means revealed females to have greater negative emotions than males with respect to helplessness ($M$ = 5.09, $SD$ = 2.67 vs. $M$ = 2.93, $SD$ = 2.00), shame ($M$ = 2.81, $SD$ = 2.33 vs. $M$ = 1.46, $SD$ = 0.92), and anxiety ($M$ = 5.04, $SD$ = 3.18 vs. $M$ = 2.85, $SD$ = 2.31). Analyses of variance (ANOVAs) did not reveal any initial differences in attributions between participants in the experimental conditions. However, ANOVAs did reveal a significant difference between students in experimental conditions on average hours per week participants use computers [$F(3, 96) = 3.08$, $p < .05$], with students in the unexpected/high importance ($M$ = 34.18, $SE$ = 4.02) and expected/high importance ($M$ = 38.30, $SE$ = 4.09) groups using computers for fewer hours per

week compared to the unexpected/low importance ($M = 47.76$, $SE = 4.64$) and expected/low importance ($M = 49.63$, $SE = 4.34$) groups.

*Correlational analyses.* Correlations between all continuous study variables are presented in Table 4. As expected, there were several significant relationships between the emotion items that showed positive emotions to be positively correlated with each other (i.e., pride and enjoyment) and negative emotions to be positively correlated with each other (i.e., anxiety and helplessness). Positive emotions also had significant and negative relationships with negative emotions (i.e., pride and anxiety). In accordance with Weiner's Attribution Theory (1985), personally controllable attributions were negatively related to negative emotions (i.e., anger) and stable attributions were positively related to negative emotions (i.e., shame). Significant positive correlations were also found between internal attributions and negative emotions (i.e., anxiety). Additionally, there was a strong correlation between internal and personally controllable attributions, which was again expected as per similar findings from research examining casual dimensions (Wang & Hall, 2014). External attributions were also negatively related to internal and personally controllable attributions, and stable attributions were negatively related to personally controllable attributions. Lastly, the average number of devices used per week was negatively related to internal attributions and anger, and positively related to feelings of pride, and enjoyment.

***Rationale for main analyses.*** The hypothesized main (attributions on emotions) and interaction (attributions by experimental conditions on emotions) effects were evaluated in the current study using linear regression analyses with covariates of gender, average hours of

Table 4
*Zero-Order Correlations Among Experimental Study Variables and Covariates*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Internal attributions | - | | | | | | | | | | | | | |
| 2. Personally controllable attributions | .62*** | - | | | | | | | | | | | | |
| 3. Stable attributions | .02 | -.20* | - | | | | | | | | | | | |
| 4. External attributions | -.25** | -.25** | -.16 | - | | | | | | | | | | |
| 5. Hope | .03 | .05 | .05 | -.12 | - | | | | | | | | | |
| 6. Guilt | .37*** | .23* | .15 | -.17 | .00 | - | | | | | | | | |
| 7. Helplessness | .15 | .02 | .10 | .00 | -.25* | .20* | - | | | | | | | |
| 8. Pride | .11 | -.02 | .11 | -.09 | .59*** | .17 | -.30** | - | | | | | | |
| 9. Anger | .40*** | .20* | .10 | -.02 | -.15 | .59*** | .36*** | -.08 | - | | | | | |
| 10. Shame | .46*** | .25* | .28** | .00 | -.06 | .57*** | .40*** | -.02 | .64*** | - | | | | |
| 11. Boredom | .29** | .13 | .08 | .07 | .20* | .35*** | .06 | .21* | .21* | .38*** | - | | | |
| 12. Anxiety | .34*** | .19 | .14 | -.09 | -.24* | .36*** | .57*** | -.41*** | .48*** | .49*** | .17 | - | | |
| 13. Relief | .06 | -.03 | .13 | -.02 | .46*** | .05 | -.28** | .64*** | -.14 | .04 | .05 | -.32** | - | |
| 14. Enjoyment | .01 | -.09 | .13 | -.05 | .52*** | .11 | -.39*** | .81*** | -.20* | -.07 | .05 | -.44*** | .82*** | - |
| Covariates | | | | | | | | | | | | | | |
| 15. Hours of computer use per week | .03 | .04 | -.04 | -.01 | -.03 | .03 | .00 | .07 | -.11 | .03 | -.11 | .05 | .19 | .09 |
| 16. Number of devices used per week | -.20* | -.13 | .08 | .03 | .17 | .07 | -.16 | .20* | -.23* | -.13 | -.01 | -.12 | .05 | .20* |

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

computer use per week, and average number of devices used per week based on results of the preliminary analyses. As in the scenario study, covariates were also chosen in accordance with previous literature showing significant relationships between computer attitudes and gender (Cooper, 2006), as well as computer use and experience (Havelka et al., 2004; McIlroy et al., 2007). Due to the high correlation between emotions of enjoyment and relief ($r$ = .82), relief was not examined in the main analyses to avoid issues of multicollinearity. All together, emotion items assessed in the main analyses consisted of hope, guilt, helplessness, pride, anger, shame, boredom, anxiety, and enjoyment.

Hypothesized effects were tested using hierarchical regressions with mean-centered predictors. In all regression analyses, Step 1 included the background variables of gender, average hours of computer use per week, and average number of devices used per week. To evaluate the study hypotheses, experimental conditions, attributions, and condition X attribution interaction terms were included in Step 2. In order to evaluate the causal dimensions of attributions independently, and to preserve statistical power, regressions for each of the four attribution dimensions (internality, personal controllability, stability, and externality) were evaluated as separate regression analyses. Experimental conditions were dummy coded with the expected/low importance group as the reference group based on Attribution Theory that assumes events that are expected and unimportant to elicit less causal search in comparison to events that are unexpected or important.

***Main analyses.***

*First-order effects.* Significant first-order effects showed the expected/high importance condition to predict pride (βs = .34-.37, $p$s < .01) and boredom (β = .32, $p$ = .01). The unexpected/high importance condition was also found to predict pride (βs = .25-.26, $p$s = .05)

and boredom (β = .35, $p < .01$), indicating predominant effects of importance with respect to emotions concerning computing difficulties. An examination of means revealed students in the expected/high importance ($M = 4.23$, $SD = 3.06$ for pride and $M = 3.85$, $SD = 2.71$ for boredom) and unexpected/high importance ($M = 3.36$, $SD = 2.60$ for pride and $M = 3.54$, $SD = 2.40$ for boredom) groups to have stronger feelings of pride and boredom compared to the unexpected/low importance ($M = 2.55$, $SD = 2.39$ for pride and $M = 3.00$, $SD = 2.83$ for boredom) and expected/low importance ($M = 2.42$, $SD = 2.06$ for pride and $M = 1.79$, $SD = 1.06$ for boredom) groups. Significant first-order effects were also found in which internal attributions predicted greater feelings of guilt (β = .47, $p < .05$) and shame (β = .57, $p < .01$). Internal attributions did not predict emotions in a manner consistent with Attribution Theory, however, effects of internal attributions on emotions as stated in Hypothesis 2 were anticipated to be confounded due to inherent properties of controllability. Hierarchical regression results for internal, personally controllable, stable, and external attributions are presented in Table 5.

*Higher order effects.* Significant interactions were found between external attributions and the unexpected/high importance condition on helplessness (Figure 7), between personally controllable attributions and the unexpected/high importance condition on anger (Figure 8), and between stable attributions and the unexpected/low importance condition on anxiety (Figure 9). External attributions were found to predict greater helplessness (β = .33, $p < .05$), and personally controllable attributions were found to predict greater anger (β = .33, $p < .05$), albeit only for students in the unexpected/high importance group. Additionally, a significant interaction effect between stable attributions and the unexpected/low importance group on anxiety (β = .33, $p < .05$) showed stable attributions to predict anxiety only for students in the unexpected/low importance group. Consistent with Hypotheses 2 and 4, external attributions were found to

Table 5

*Experimental Study Hierarchical Regression Results by Attributions*

| Predictor | Hope | Guilt | Helplessness | Pride | Anger | Shame | Boredom | Anxiety | Enjoyment |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Internal attributions | | | | | |
| Step 1 | | | | | | | | | |
| Gender | -.04 | .04 | .38*** | -.12 | .11 | .30** | -.03 | .33** | -.16 |
| Computer use | -.05 | .07 | .08 | .02 | -.08 | .08 | -.09 | .13 | .02 |
| Devices used | .18 | .08 | -.17 | .22* | -.23* | -.13 | -.01 | -.15 | .22* |
| $R^2$ | .04 | .01 | .17*** | .07 | .08 | .11** | .01 | .13** | .08 |
| Step 2 | | | | | | | | | |
| Internal attributions (In) | .23 | .47* | -.10 | .21 | .38 | .57** | .06 | .41 | .15 |
| Unexpected/High importance (U/H) | .03 | .16 | .07 | .25* | .16 | .12 | .35** | .08 | .10 |
| Unexpected/Low importance (U/L) | -.12 | .09 | -.06 | .06 | .05 | .08 | .24 | .00 | .04 |
| Expected/High importance (E/H) | .15 | .06 | -.12 | .34** | -.07 | .03 | .32** | -.11 | .21 |
| In X U/H | -.03 | .09 | .03 | .10 | .17 | -.09 | .18 | -.05 | .02 |
| In X U/L | -.15 | -.04 | .12 | -.01 | .06 | -.02 | .08 | -.07 | .02 |
| In X E/H | -.20 | -.13 | .18 | -.19 | -.14 | -.16 | .05 | -.09 | -.15 |
| $R^2$ | .10 | .20* | .22* | .21* | .27** | .28*** | .20* | .23* | .13 |

See *Note* at the bottom of Table 5. *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Table 5 *(continued)*

*Experimental Study Hierarchical Regression Results by Attributions*

| Predictor | Hope | Guilt | Helplessness | Pride | Anger | Shame | Boredom | Anxiety | Enjoyment |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Personally controllable attributions | | | | | |
| Step 2 | | | | | | | | | |
| Personally controllable attributions (Pc) | .17 | .08 | -.02 | .03 | .08 | .31 | .16 | .23 | -.06 |
| U/H | .08 | .21 | .08 | .26* | .24 | .17 | .33* | .12 | .09 |
| U/L | -.08 | .08 | -.10 | .05 | -.01 | .07 | .24* | .01 | .03 |
| E/H | .17 | .11 | -.11 | .37** | -.03 | .10 | .38** | -.06 | .23 |
| Pc X U/H | .03 | .23 | .03 | .10 | .33* | -.06 | -.04 | .00 | .05 |
| Pc X U/L | -.05 | .13 | -.07 | .07 | -.08 | .03 | .21 | -.02 | .08 |
| Pc X E/H | -.17 | .03 | .10 | -.19 | .00 | -.08 | -.11 | -.04 | -.15 |
| $R^2$ | .10 | .12 | .21* | .20* | .21* | .18 | .18 | .18 | .14 |
| | | | | Stable attributions | | | | | |
| Step 2 | | | | | | | | | |
| Stable attributions (St) | .12 | -.08 | -.03 | -.05 | -.03 | .17 | .03 | -.23 | -.05 |
| U/H | .01 | .10 | .08 | .21 | .09 | .06 | .30* | .03 | .07 |
| U/L | -.09 | .07 | -.09 | .04 | .00 | .03 | .20 | .00 | .03 |
| E/H | .14 | .08 | -.12 | .33** | -.05 | .05 | .39** | -.07 | .14 |
| St X U/H | -.02 | .17 | -.02 | .06 | .12 | .11 | .05 | .23 | .15 |
| St X U/L | -.09 | .07 | .15 | .03 | .03 | .04 | -.02 | .33* | .02 |
| St X E/H | -.11 | .18 | .15 | .09 | .13 | .10 | -.02 | .25 | .12 |
| $R^2$ | .07 | .05 | .22* | .15 | .13 | .20* | .12 | .20* | .12 |

See *Note* at the bottom of Table 5. *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Table 5 *(continued)*

*Experimental Study Hierarchical Regression Results by Attributions*

| Predictor | Hope | Guilt | Helplessness | Pride | Anger | Shame | Boredom | Anxiety | Enjoyment |
|---|---|---|---|---|---|---|---|---|---|
| | | | | External attributions | | | | | |
| Step 2 | | | | | | | | | |
| External attributions (Ex) | .12 | -.07 | -.26 | .08 | .08 | .00 | -.03 | .08 | .06 |
| U/H | .03 | .17 | .06 | .23 | .13 | .11 | .30* | .06 | .09 |
| U/L | -.07 | .10 | -.08 | .06 | -.03 | .04 | .22 | .01 | .05 |
| E/H | .13 | .14 | -.12 | .33** | .00 | .13 | .41** | -.11 | .22 |
| Ex X U/H | -.20 | -.19 | .33* | -.14 | -.23 | .02 | .12 | -.11 | -.10 |
| Ex X U/L | -.16 | -.10 | .17 | -.16 | .02 | .01 | -.06 | -.11 | -.17 |
| Ex X E/H | -.07 | .09 | .01 | -.05 | .06 | .08 | .11 | -.13 | .03 |
| $R^2$ | .10 | .09 | .25** | .18 | .13 | .12 | .13 | .16 | .14 |

*Note.* Step 1 values for the internal attribution analyses were highly similar to those for the personally controllable, stable, and external attribution analyses and are not presented. Standardized β coefficients and $R^2$ values are provided for regressions on study measures. Regression coefficient and $R^2$ values are for the step in which they were first entered. Significance of $R^2$ values indicates two-tailed significance of change from previous step. *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

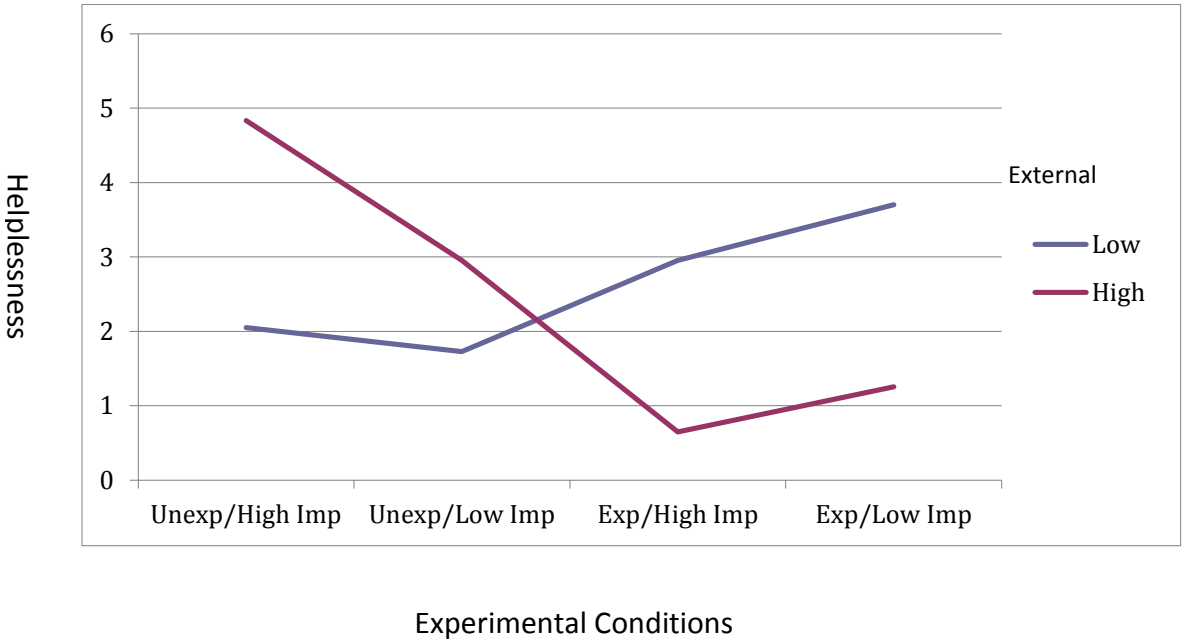


*Figure 7.* Effects of external attributions by experimental conditions for feelings of helplessness.

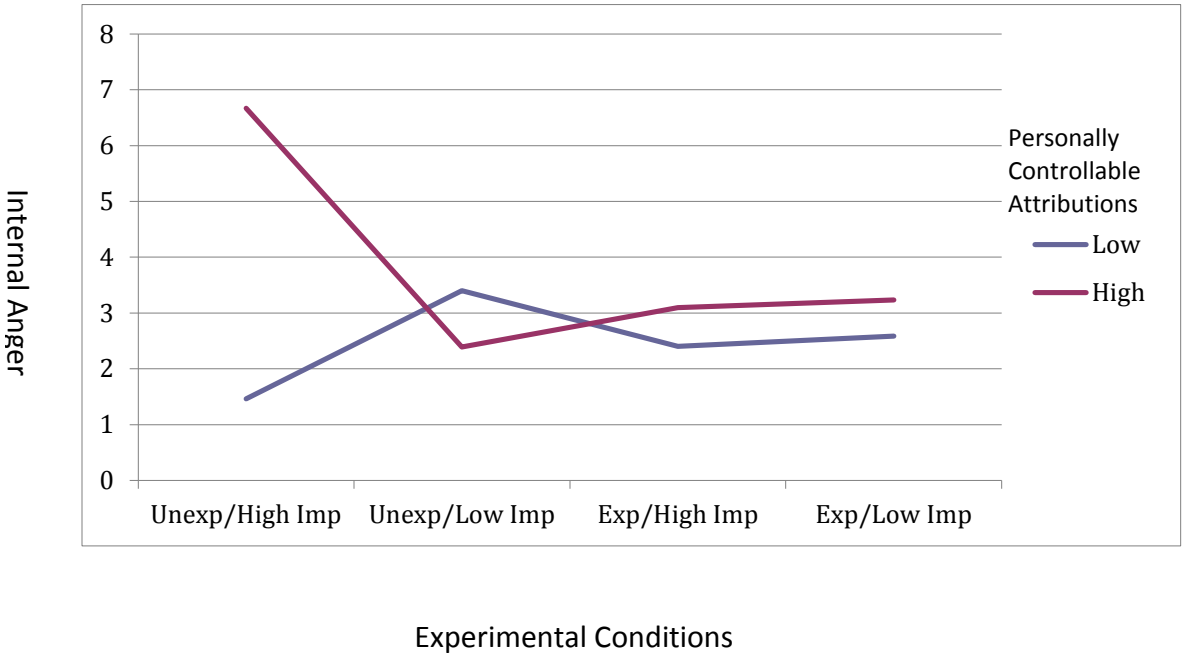


*Figure 8.* Effects of personally controllable attributions by experimental conditions for feelings of anger.

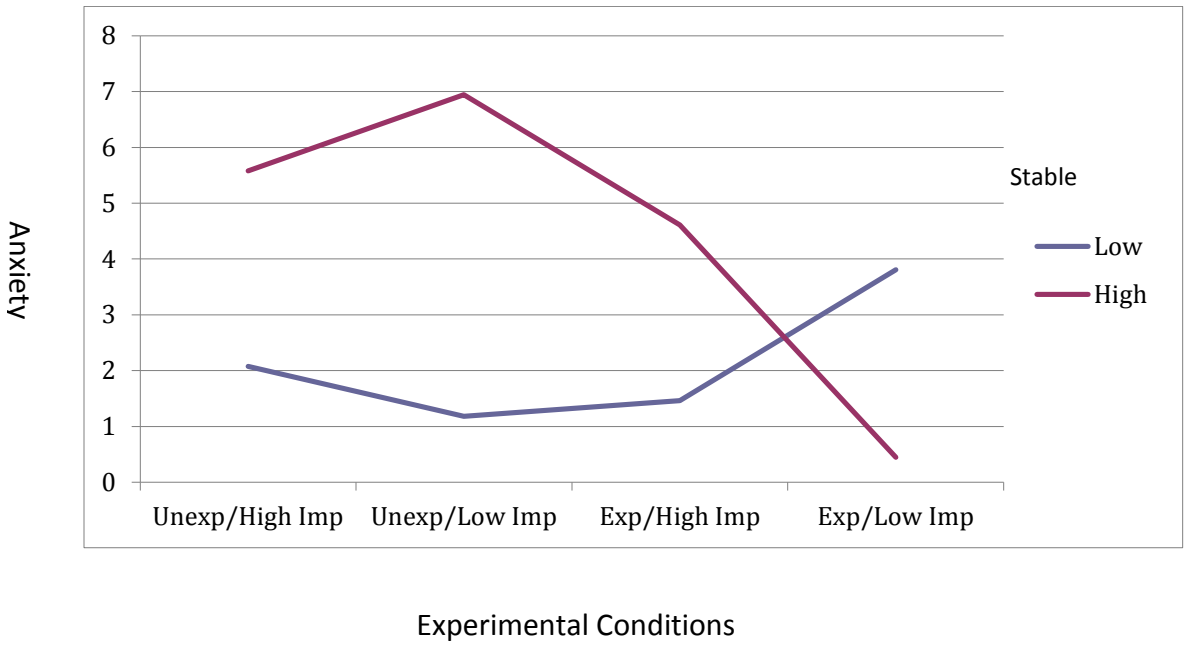


*Figure 9.* Effects of stable attributions by experimental conditions for feelings of anxiety.

predict more negative emotions (i.e., helplessness), and specifically in the condition hypothesized to elicit the most causal search. Moreover, as anticipated in Hypothesis 3, stable attributions were found to predict more negative emotions (i.e., anxiety), with this effect found only in a condition assumed to elicit greater than the minimum causal search (partial support for Hypothesis 4). Contrary to the anticipated results specified in Hypothesis 1, personally controllable attributions were found to predict more negative emotions (i.e., anger), and in direct contrast to Hypothesis 4, did so only in the most causal-search-eliciting condition.

**Discussion.**

***Hypotheses.*** As informed by Weiner's Attribution Theory (1985, 2000, 2010) and previous research on attributions for academic achievement, personally controllable attributions for technology-related problems were expected to predict more positive and less negative

emotions concerning educational technology use (Hypothesis 1). On the contrary, personally controllable attributions were found to predict negative attributions (i.e., anger) for students who experienced unexpected and highly important problems. Similar to findings for anger in the scenario study, the present finding of personally controllable attributions to predict feelings of anger is novel in that anger is typically addressed as a social emotion rather a self-directed emotional experience in Weiner's Attribution Theory. In contrast with the emotional benefits of personally controllable attributions observed in the scenario study, findings from the present study indicate that personally controllable attributions for technological difficulties (i.e., effort) may not be as beneficial as previous expected.

As indicated in Hypothesis 2, external attributions for technology-related problems were expected to predict less positive and more negative emotions concerning educational technology use, whereas internal attributions were expected to predict more positive and less negative emotions according to Attribution Theory. Accordingly, external attributions were found to predict negative emotions (i.e., helplessness) for students in the unexpected/high importance group. Interestingly, the emotional disadvantages of external attributions observed in the experimental study contradict the emotional benefits of external attributions found in the scenario study. One explanation for this effect is that students' anticipated reactions to technological difficulties are not indicative of their responses to actual problems, underscoring the importance of experience-based methodologies in future research with technology-related motivation and emotions. Contrary to Hypothesis 2, internal attributions were found to predict negative emotions (i.e., anger). As anticipated, these findings were not unexpected due to the high correlation between internal and personally controllable attributions.

According to the third hypothesis, stable attributions for technology-related problems were expected to predict less positive and more negative emotions concerning educational technology use (albeit to a lesser extent than controllable attributions). The finding of stable attributions to predict negative emotions (i.e., anxiety) for students who experienced a problem that was unexpected and of low importance supported Hypothesis 3. Compared to unstable attributions (i.e., lack of familiarity), stable attributions (i.e., lack of ability) have consistently been found to predict negative emotions, poor academic performance, and attrition for university students (Haynes et al., 2009; Van Overwalle et al., 1995). Additionally, the observed emotional disadvantages of stable attributions were observed across both the scenario and experimental studies in the present research.

The fourth hypothesis proposed that the emotion effects of causal attributions would be most evident following the experimental condition with a technological problem that was unexpected and of high importance, whereas the emotional effects of attributions would be least evident in the condition with a technological failure that was expected and of low importance. Although emotional disadvantages of external attributions were indeed found for the unexpected/high importance group, emotional *disadvantages* of personally controllable attributions were found to be most evident for students in the unexpected/high importance group thus directly contradicting Hypothesis 4. Moreover, the disadvantages of stable attributions (or conversely, the benefits of unstable attributions) were found mainly for the unexpected/low importance group, providing partial support for the assumption in Hypothesis 4 that stronger effects of attributions should be observed in conditions eliciting more causal search.

***Limitations.*** With respect to the interpretation of results for the experimental study, there are also several limitations to be considered. The absence of a control group does not allow for

causal assumptions regarding the relationships between precursors to causal search, attributions, and emotions. Additionally, causal attributions and attribution-related emotions were not assessed directly in relation to the technological difficulty experienced, as to preserve the believability of the manipulation. The application of Attribution Theory is most relevant for attributions and emotions assessed for a specific event (in this case attributions and emotions were assessed in relation to academic computer use in general), however, previous studies of attributional patterns have provided significant contributions to research in this domain (e.g., Dickhäuser & Stiensmeier-Pelster, 2002). Another limitation of the present study was participant attrition, with approximately 55% of the sample completing the entire study. Although preliminary analyses revealed data to be missing completely at random, such a high participant attrition rate warrants caution when interpreting results. It is possible that the experimental manipulation employed would discourage some students more than others (i.e., highly motivated vs. less motivated students) even though participant attrition was not significantly related to other study variables.

Similar to the scenario study, there were also methodological and conceptual limitations of the experimental study. Such limitations include the use of self-report data to obtain participant information, as well as the use of single item measures for the emotion items. Also similar to the scenario study, the reliability for the stability measure was low enough to warrant caution when interpreting results involving stable attributions. Additionally, the present cross-sectional findings do not allow for the speculation of longitudinal effects, and research that examines a larger sample of students from additional populations (i.e., online learning universities) is recommended to further evaluate the replicability of the present findings. Lastly,

it should be noted that the scenario and experimental studies are not directly comparable due to differing technological difficulties for each study.

***Implications and future directions.*** Overall, findings from the experimental study presented noteworthy effects of causal attributions on achievement-related emotions with regard to technological difficulties encountered in academic contexts. Findings of stable and external attributions to predict demotivating emotions (i.e., anxiety) for students who experienced a technological problem that was unexpected and/or highly important suggest that encouraging students to make more unstable attributions for computer problems may be an effective intervention technique (Wilson & Linville, 1982, 1985). Although attributional interventions (e.g., attributional retraining; Hall et al., 2004, 2007) typically encourage personally controllable attributions, the absence of anticipated emotional benefits from personally controllable attributions following technological difficulties suggests that such programs are unlikely to be successful. Additionally, effects pertaining to stable attributions in the experimental study should also be interpreted with caution due to low scale reliability.

## Conclusion

The present research aimed to investigate the relationships between causal attributions and emotions specific to academic-related technological challenges. In order to provide a more comprehensive understanding of how university students' causal attributions influence emotions in technology mediated academic contexts, two studies were employed to assess the anticipated relationships in both hypothetical scenarios and experimentally manipulated situations. Findings from both studies provided partial support for the hypothesized effects, including the negative effects of stable attributions for students who are likely to engage in causal search (i.e., those who experience unexpected or important technological problems). Interactions between

condition type and causal attributions on emotions in both studies also provide support for significant effects of attributions on achievement-related emotions relative to the academic computing domain, in that conditions eliciting greater causal search were those for which the effects of causal attributions were observed.

Overall, findings from the current studies did not precisely coincide with Attribution Theory, indicating that relationships involving personally controllable and external attributions may function differently for university students when technological difficulties are encountered. Given the inconsistent effects of external attributions observed in the hypothetical and experimental studies, further research in which these effects are replicated is necessary. However, previous findings of differing interactions between hypothetical scenario and in vivo studies that examined precursors of causal search in relation to academic performance outcomes in university students also found conflicting results (Stupnisky et al., 2011). In addition to empirical contributions of the current studies to the examination of Attribution Theory in the academic computing domain, the present research also provides empirical support for domain specific variations of the CDSII (at least for dimensions of locus of causality, personal control, and external control) and AEQ developed for this study (Pekrun et al., 2011). Given the absence of emotionally beneficial effects for attributions on achievement-related emotions, longitudinal research that examines such effects in relation to technological difficulties is required if optimally motivating programs for undergraduate students are to be developed. It is anticipated that a more comprehensive understanding of attributional beliefs that are optimal when responding to technological challenges will allow for improved support for university students as digital literacy becomes increasingly important in higher education.

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Appendix A

Informed Consent

**CONSENT TO ACT AS A HUMAN RESEARCH SUBJECT**
You are being asked to participate in a research study. Participation in this study is completely voluntary. Please read the information below and ask questions about anything that you do not understand before deciding if you want to participate. A researcher listed below will be available to answer your questions.

**TITLE OF STUDY**
Technology and Motivation in Higher Education

**RESEARCH TEAM**
Rebecca Maymon (Master's Student, Educational Psychology)
rebecca.maymon@mail.mcgill.ca

Dr. Nathan C. Hall
nathan.c.hall@mcgill.ca

**PURPOSE OF STUDY**
The purpose of this study is to learn about student experiences with technology.

**ELIGIBLE SUBJECTS**
McGill undergraduate students (18 years of age or older) are eligible to participate in this study.

**PROCEDURES**
If you would like to participate, we will ask you to complete a questionnaire including questions regarding your computer use, experiences, and attitudes. You may also be asked to read and respond to a brief online reading. The study is completed entirely over the Internet and will require 20 to 30 minutes of your time.

**COMPENSATION, COSTS AND REIMBURSEMENT**
Participants will be entered into a draw for one of two cash prizes of $250. Odds of winning are approximately 1 in 200. Participants who wish to be entered into the cash prize draw will be asked to provide a McGill email address as a contact for draw winnings.

**CONFIDENTIALITY**
**Subject Identifiable Data:**
All identifiable information that will be collected about you will be removed at the end of data collection.
**Data Storage:**
All research data will be stored electronically on a secure computer with encryption and password protection, with extra encryption provided for identifying information.

**Data Access:**
Only the research team may have access to your study records. Any information derived from this research project that personally identifies you will not be voluntarily released or disclosed by the research team without your separate consent, except as specifically required by law.
**Data retention:**
The researchers intend to keep the research data in electronic format for at least 7 years.
**Dissemination of results:**
The results of this study will be presented during a poster presentation in Spring 2014. Furthermore, the results will be presented in a manuscript to be submitted to an academic, peer-reviewed journal in the field of educational psychology in Fall 2014. All results will be presented at the group level with all identifying information removed prior to analysis.

**RISKS AND DISCOMFORTS**
There are risks involved in all research studies. This study is anticipated to include only minimal risk, with no known harms or discomforts associated with this study beyond those encountered in normal daily life. A possible risk of participation in this study is mild anxiety that may be associated with completing a questionnaire on emotion-related topics (e.g., anxiety).

**BENEFITS**
**Subjects Benefits:**
Possible benefits you may experience from study participation include an opportunity to reflect on your motivation as a student and your habits regarding computer use.

**Benefits to Others or Society:**
The possible benefits of this study to others involve providing empirical support for motivational programs to improve university students' experiences while working with technology.

**VOLUNTARY PARTICIPATION STATEMENT**
Participation in this study is voluntary. You may refuse to answer any question or discontinue your involvement with the study until data is de-identified at the end of data collection (one month following survey completion) without any penalty or loss of benefits to which you might otherwise be entitled. Your decision will not affect your future relationships with McGill University.

**IF YOU HAVE QUESTIONS**
If you have any comments, concerns, or questions regarding the conduct of this research, please contact the researchers listed above via email. If you have any questions or concerns regarding your rights or welfare as a participant in this research study, please contact the McGill Ethics Officer at 514-398-6193 or deanna.collin@mcgill.ca.

Please feel free to copy/print the consent information above for your records. You should not log in to the study unless you have read the above information.

Please note that your McGill ID number is requested to validate student status at McGill and to confirm identification of prize winners. If you wish to be entered into the cash draw, please

provide a McGill email address to contact. All identifying information (name, ID and email address) will be removed following the completion of data collection (one month following survey completion).

McGill ID Number: _____ McGill Email Address: _____

First Name: _____ Last Name: _____

# Appendix B

## Questionnaire Items

[Preamble for Experimental Study Conditions 1 & 2]

Thank you for your participation in this study. Please note that some participants have experienced technical difficulties with the study website. If you encounter any problems while completing the study, please let us know on the comments page at the end of the study.

[Preamble for Experimental Study Conditions 3 & 4]

Thank you for your participation in this study. Please feel free to provide any feedback on the comments page at the end of the study.

[Demographics]

In this part of the survey, we ask for some factual information about you. Your answers to all of the questions are CONFIDENTIAL.

What is your gender?

1) Male
2) Female
3) Other (please specify) _____

What is your age in years? _____

Which faculty/school are you currently registered in?

1) Faculty of Agricultural and Environmental Sciences
2) Faculty of Arts
3) Faculty of Dentistry
4) Faculty of Education
5) Faculty of Engineering
6) Faculty of Law
7) Management
8) Faculty of Medicine
9) Schulich School of Music
10) Faculty of Religious Studies
11) Faculty of Science
12) McGill School of Environment
13) Bachelor of Arts and Science

What was your average (%) in your last year of schooling prior to starting university (high school / CEGEP)? _____

What is your first language?

1) English
2) French
3) Chinese languages
4) Arabic
5) Punjabi / Hindi / Urdu
6) Italian
7) Tagalog
8) Spanish
9) German
10) Portuguese
11) Tamil
12) Other (please specify) _____

What is your class standing?

1) First Year Undergraduate
2) Second Year Undergraduate
3) Third Year Undergraduate
4) Fourth Year Undergraduate
5) Fifth + Year Undergraduate

[Computer Experience and Usage]

Please answer the following questions relating to your general use of computers (tablets, laptops, desktops, smartphone, etc.).

On average, how many TOTAL estimated hours per week do you spend using computers? ____

How many estimated hours per week do you spend using computers for school? _____

How many estimated hours per week do you spend using computers for fun? _____

How would you rate your computer experience compared to others?

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| None | | | | Excellent |

Please select the devices you use in an average week (you may check more than one box).

Desktop
Laptop
Smart phone
Tablet
Gaming system (e.g., PlayStation)
Other (please specify) _____

What type of device are you currently using to complete this study?

Desktop
Laptop
Tablet
Smartphone
Other (please specify) _____

[Causal Dimension Scale II]

Now we would like to ask you to think about a time in the past when you were using a computer device (e.g., tablet, laptop, desktop, smartphone, etc.) for school-related purposes and you experienced a computer problem (e.g., error messages, "freezing," crashing, etc.).

In the text box below, please briefly describe the primary reason that is responsible for why this problem occurred.

Think about the primary reason you entered above. The items below concern your impression or opinion about this cause of your experience. Select one number for each of the following statements.

The cause:

| | | | |
|---|---|---|---|
| 1. | Reflects an aspect of myself | 9 8 7 6 5 4 3 2 1 | reflects an aspect of the situation |
| 2. | Is manageable by me | 9 8 7 6 5 4 3 2 1 | is not manageable by me |
| 3. | Is permanent | 9 8 7 6 5 4 3 2 1 | is temporary |
| 4. | Is something I can regulate | 9 8 7 6 5 4 3 2 1 | is something I cannot regulate |
| 5. | Is something over which others have control | 9 8 7 6 5 4 3 2 1 | is something over which others have no control |
| 6. | Is inside of me | 9 8 7 6 5 4 3 2 1 | is outside of me |
| 7. | Is stable over time | 9 8 7 6 5 4 3 2 1 | is variable over time |
| 8. | Is under the power of other people | 9 8 7 6 5 4 3 2 1 | is not under the power of other people |
| 9. | Is something about me | 9 8 7 6 5 4 3 2 1 | is something about others |
| 10. | Is something over which I have power | 9 8 7 6 5 4 3 2 1 | is something over which I have no power |
| 11. | Is unchangeable | 9 8 7 6 5 4 3 2 1 | is changeable |
| 12. | Is something other people can regulate | 9 8 7 6 5 4 3 2 1 | is something other people cannot regulate |

### *Unique Scenario Study Measures*

[Attribution-Related Emotions (Scenario Version)]

Imagine yourself in the situation described below and indicate the extent to which each of the following emotions describes how you would feel:

[One randomly assigned scenario will be presented (see "Hypothetical Scenarios" under Methodology/Procedures section above).]

IN THIS SITUATION I WOULD FEEL:

1 2 3 4 5 6 7 8 9 10
Not at All Very Much So

1. Hopeful
2. Guilty
3. Helpless
4. Proud
5. Angry at Myself
6. Angry at Others
7. Ashamed
8. Happy
9. Regret
10. Bored
11. Anxious
12. Relieved
13. Enjoyment

### *Unique Experimental Study Measures*

[Experimental Conditions (1-4): Page 1]

Please read the following article carefully. Your understanding and opinions about the information in this article will be assessed on the following page and you will not be able to refer back to the article after leaving this page (see Appendix C for article).

[Experimental Conditions: Page 2]

*Low Importance Conditions*
Please use the space provided below to summarize and discuss the implications of the article presented on the previous page as clearly as possible. Please also ensure your response is one paragraph long (about five sentences) prior to proceeding to the next page, and remember that all responses provided are confidential and will be used to inform the development of future studies.

*High Importance Conditions*

Please use the space provided below to summarize and discuss implications of the article presented on the previous page. Please also ensure your response is three paragraphs long (about five sentences each) prior to proceeding to the next page, and remember that all responses provided are confidential and will be used to inform the development of future studies.

[Attribution-Related Emotions for Experimental Conditions (1-4)]

Please indicate the extent to which each of the following emotions describes how you feel <u>when experiencing problems using computers for school</u> (including tablets, smartphones, etc.):

1 2 3 4 5 6 7 8 9 10
Not at All Very Much So

I FEEL:

1. Hopeful
2. Guilty
3. Helpless
4. Proud
5. Angry at Myself
6. Angry at Others
7. Ashamed
8. Happy
9. Regret
10. Bored
11. Anxious
12. Relieved
13. Enjoyment

Appendix C

Article for Experimental Conditions

# A Wealth of Data in Whale Breath

MYSTIC, Conn. — On her trainer's command, an alabaster-skinned beluga whale named Naku placed her chin on the deck of her outdoor pool and exhaled several times, emitting a hollow "chuff" sound with each breath. The vapor rose into a petri dish a researcher held over her blowhole.

Those tiny drops contain a wealth of information, it turns out. Researchers at Mystic Aquarium and elsewhere are learning how to use the breath, or "blow," of whales and dolphins to extract and measure hormones, microorganisms, DNA and the byproducts of metabolism.

Their goal is not only to improve the health of captive cetaceans like Naku, but also to develop a powerful, unobtrusive technique for studying them. While blood is the gold standard in physiological research, it can be hard to obtain — and all but impossible from large whales. Three new studies describe advances in breath analysis, which may prove to be the next best thing.

"I suspect that everything that's in the blood is in the blow, just at much lower concentration, a little harder to measure," said Kathleen Hunt, a research scientist at the New England Aquarium in Boston. "All kinds of goodies that we could learn a lot from that we've never been able to get from these animals."

Doctors have long sniffed their patients' breath to diagnose a variety of diseases. But gadgets may soon replace noses, with chemical breath tests under development for a host of human ailments, including asthma, cancer, diabetes and tuberculosis.

Trainers and veterinarians working with captive whales and dolphins also routinely smell their breath. Normal dolphin breath has a fishy smell; rotten-egg scents signal digestive problems, and sweet ones indicate bacterial pneumonia, according to Sam Ridgway, a veterinarian and neurobiologist at the National Marine Mammal Foundation in San Diego. In 1969, Dr. Ridgway published the first basic cetacean-breath study, exploring a dolphin's diving ability.

Four decades later, advances in chemical sensing, computing and human breath analysis drew Dr. Ridgway's team and perhaps a half-dozen others back to cetacean breath in earnest. In 2009, researchers reported detecting the hormones progesterone and testosterone in blow from humpback and North Atlantic right whales — potential clues to their sex and reproductive state.

The paper, published in the journal Marine Mammal Science, showed that blow analysis might really work.

A few months later, another team using a remote-controlled helicopter to collect blow samples reported finding potentially pathogenic bacteria in the breath of five whale species. The whales watched the helicopter buzz overhead, but otherwise seemed unperturbed, said the lead researcher, Karina Acevedo-Whitehouse, a molecular epidemiologist at the Autonomous University of Querétaro in Mexico. “In terms of what we normally do with wildlife — restraint and capture and collecting samples — this is as noninvasive as you can get.” (The paper, published in the journal Animal Conservation, earned its authors the satirical but coveted Ig Nobel Prize from the magazine Annals of Improbable Research.)

After those papers, others dived in, several financed by the federal Office of Naval Research. Scientists at Mystic Aquarium are studying reproductive and stress hormones, as well as DNA, in the breath of Naku and her three poolmates. Not only do the four belugas blow on demand, but they also flop their tails onto the pool deck so researchers can draw blood and collect fecal samples. They open their jaws for saliva swabbings (and toothbrushings) — all in exchange for a few fish or some pats on their bubble-gum-pink tongues.

Being able to compare results from all four bodily fluids is a huge advantage in working out study methods, said Tracy Romano, the project’s leader. So is being able to monitor and control virtually every aspect of the belugas’ lives. “We know the health of the animals,” she said. “We know the age; we know what the animals are eating; we know the water chemistry.”
In San Diego, scientists at the National Marine Mammal Foundation are studying a group of highly cooperative dolphins trained to locate sea mines and swimmers for the United States Navy. Their breath has already yielded hundreds of compounds — a fortune in molecules.
“We looked at the samples and were like ‘All right!’ There is so much stuff in there,” said the study’s director, Cristina Davis, a chemical sensing expert at the University of California, Davis. “There’s a tremendous amount of room for discovery.”

# Appendix D

## Debriefing Forms

[Debriefing for Experimental Conditions]

Thank you for participating in our study. This online study is now complete and your data has been saved. If you have any questions or concerns, please email the experimenter directly at rebecca.maymon@mail.mcgill.ca. Be sure to check your email for information on the prize draw results for this study.

The purpose of this study is to examine university students' computer usage, attitudes and motivation. Technology is increasingly incorporated into class activities, coursework, and many other aspects of university education. Consequently, computer errors are commonly experienced and can have negative effects on student attitudes, motivation and performance. We predict that certain motivational strategies for dealing with computer problems will help students in their academic experiences. We aim to use results from this study to help university students utilize more helpful motivational strategies when experiencing technological difficulties.

To examine the best ways of dealing with computer problems in various academic situations, our study design included a computer error message in the page following your typed response to the article. There was no error and no text was lost. The error was intended mainly to elicit minor feelings of anxiety and to simulate a typical loss of data in normal academic activities (e.g., losing a brief writing assignment or email). All of your data, including your typed response to the article, has been saved and will be used in analyses.

If you are uncomfortable with the present study or being misled, you are free to withdraw your data from the sample by contacting the researcher. However, all of your results are CONFIDENTIAL and all results are published anonymously as group data. If you wish to express any concerns about the present study you can contact any of the following people:

Researcher: Rebecca Maymon rebecca.maymon@mail.mcgill.ca
Faculty: Dr. Nathan Hall nathan.c.hall@mcgill.ca
McGill REB Manager: Deanna Collin deanna.collin@mcgill.ca or (514) 398-6193

If you would like any information about the results of the study once it is completed, feel free to contact Rebecca Maymon or Dr. Nathan Hall. If you are interested in learning about the study findings, please visit www.ame1.net/mcgilltechstudy after September 1st, 2014 for preliminary findings. To learn more about this topic, please feel free to download the following articles, which are available through the McGill library.

Hawi, N. (2010). Causal attributions of success and failure made by undergraduate students in an introductory-level computer programming course. *Computers & Education, 54,* 1127-1136. http://dx.doi.org/10.1016/j.compedu.2009.10.020

Koch, S. C., Müller, S. M., & Sieverding, M. (2008). Women and computers. Effects of stereotype threat on attribution of failure. *Computers & Education, 51,* 1795-1803. http://dx.doi.org/10.1016/j.compedu.2008.05.007

We ask you to please refrain from talking about this study with other students until the conclusion of the study one month from now. Since attitudes and strategies for dealing with computer problems are optimally measured directly following the experience of a computer problem, telling future participants about the nature of the study may influence their responses. Thank you once again for your participation.

[Conclusion for Scenario Conditions]

Thank you for participating in our study. This online study is now complete and your data has been saved. If you have any questions or concerns, please email the experimenter directly at rebecca.maymon@mail.mcgill.ca. Be sure to check your email for information on the prize draw results for this study.

The purpose of this study is to examine university students' computer usage, attitudes and motivation. Technology is increasingly incorporated into class activities, coursework, and many other aspects of university education. Consequently, computer errors are commonly experienced and can have negative effects on student attitudes, motivation and performance. We predict that certain motivational strategies for dealing with computer problems will help students in their academic experiences. We aim to use results from this study to help university students utilize more helpful motivational strategies when experiencing technological difficulties.

We would like to remind you that all of your results are CONFIDENTIAL and all results are published anonymously as group data. If you wish to express any concerns about the present study you can contact any of the following people:

Researcher: Rebecca Maymon rebecca.maymon@mail.mcgill.ca
Faculty: Dr. Nathan Hall nathan.c.hall@mcgill.ca
McGill REB Manager: Deanna Collin deanna.collin@mcgill.ca or (514) 398-6193

If you would like any information about the results of the study once it is completed, feel free to contact Rebecca Maymon or Dr. Nathan Hall. If you are interested in learning about the study findings, please visit www.ame1.net/mcgilltechstudy after September 1st, 2014 for preliminary findings. To learn more about this topic, please feel free to download the following articles, which are available through the McGill library.

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We ask you to please refrain from talking about this study with other students until the conclusion of the study one month from now, as telling future participants about the study may influence their responses. Thank you once again for your participation.