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STUDENT RETENTION IN INFORMATION SYSTEMS MAJORS: THE ROLE OF CREATIVE SELF-EFFICACY

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Abstract:

At times the Information Systems (IS) major has suffered from declining enrollment. Also, STEM fields such as IS are known to suffer from a lack of gender diversity. This research focuses on why students drop out from IS programs and how to provide actionable feedback to improve student retention, particularly among female students. We use creative self-efficacy (CreaSE) as a theoretical lens to explain student retainment. In particular, as students have more confidence in their ability to solve business problems with IS solutions, they are more likely remain in IS courses. Students who sought help from their instructor and StackOverflow.com developed greater CreaSE. However, women were less likely to seek help in general, which creates unique opportunities for future research.

Keywords: Information Systems, CreaSE, Gender, Retention

I. Introduction

At times, the information systems (IS) discipline has suffered from declining enrollment [Koch and Kayworth 2007; Lomerson and Pollacia 2006]. In addition, STEM (Science, Technology, Engineering, and Math) fields, including IS, are known to suffer from a lack of gender diversity [Beyer et al. 2003; Cheryan et al. 2009; Moudgalya et al. 2019].

While student retention has been well-studied in computer science and engineering, there is a lack of research in the IS context [Brainard and Carlin 1998; Croasdell et al. 2011; Giannakos et al. 2017b; Gokhale et al. 2015; Malgwi et al. 2005; Wang et al. 2013]. IS differs from other STEM fields in that it requires not only information technology expertise, but also an understanding of business processes and human psychology that interacts with IS [Sidorova et al. 2008]. However, throughout this paper for sake of simplicity and references, we will frequently include IS in STEM. One of the key characteristics of high performing IS professionals is their ability to be creative as they build systems to solve new or unstructured business problems [Couger et al. 1993; Nunamaker Jr et al. 1987; Tiwana and Mclean 2005]. In other words, IS requires a degree of creativity that includes people and processes rather than technology alone; thus, making it a unique context to study and understand student retention.

While prior research has focused on understanding why students select the IS field from the early stages (e.g. high school) [Koch and Kayworth 2007; Lomerson and Pollacia 2006], we focus on a different problem—why students drop out from IS programs after starting them. In this scenario, discovering IS programs and their intended purpose is not part of the scope. Rather, students have begun IS courses, but decide to either drop the necessary class they are in or cancel their enrollment in further courses after completing an initial course. Therefore, our research question is, *why do students drop information systems courses and programs?*

There are a number of factors that explain whether or not a student (and often women in particular) will be persistent in a STEM major including quality of education, social impact, academic interaction, and perhaps most commonly one's belief in their own abilities —self-efficacy [Marra et al. 2009]. Self-efficacy perceptions have been shown to be a strong indicator of student performance and drive in their major [Crocker et al. 2003]. However, the effect of classroom instruction on student's self-efficacy improvements are somewhat mixed [Hutchison et al. 2006; Marra et al. 2009].

These mixed results may be from an improper focus on the type of self-efficacy that is most relevant in IS. As stated above, IS is broader than the information technology domain alone. Therefore, while prior research has focused on general self-efficacy or a technology-specific self-efficacy [Beyer 2014; Miura 1987; Ramalingam and Wiedenbeck 1998; Wilson 2002], we draw from recent theory on *creative self-efficacy* (CreaSE) which refers to an individual's confidence in their ability to solve unstructured business problems with creative IS-based solutions [Payne et al. 2018]. CreaSE—in any domain—has not been studied as an antecedent of persistence in a STEM field.

Furthermore, while known antecedents of self-efficacy (mastery of experience, social influence, vicarious experience, physiological state) have been examined in prior research [Marra et al. 2009], we take a greater focus on *vicarious experience* which refers to the development of self-efficacy through observation of others [Bandura 1977]. Vicarious experience is particularly relevant in the classroom context because students have the option of observing a variety of others including their instructor, teaching assistants, peers, friends, family members, and online sources (e.g. stakeoverflow.com) who have experience in the content they are trying to learn.

In summary, we make three unique contributions: 1) we examine the problem of student (and women in particular) retention in the IS domain as opposed to other STEM fields, 2) we expand the definition of vicarious experience to explain how the observation of creative individuals can improve the self-efficacy developed in the classroom, and 3) we draw from a more appropriate self-efficacy lens for the IS domain (CreaSE) in order to better explain how self-efficacy is developed from vicarious experience. In addition, we validate the role of CreaSE in explaining student retainment.

To accomplish our objectives, we gathered and analyzed survey data from students (n=182) that registered for an IS course on beginning-level programming skills that is a requirement for the IS major at a large private university in the western United States (US). Our results indicate that CreaSE is a very strong predictor of student retainment. Men were more likely than women to seek help (i.e. obtain vicarious experience) from stackoverflow.com, other people, other online sources, and family. Interestingly, while students sought help from (i.e. obtained vicarious experience) a wide variety of sources, their CreaSE improved only when they sought help from 1) stackoverflow.com and 2) their instructor.

II. Background and Related Work

Previous research has shown that there are many factors that influence a student's persistence in STEM-related courses or majors. Among the components that impact retention are class enjoyment/affect, career opportunities, quality of education, social image, grades, prior experience, and mentorship. These components will be discussed briefly based upon prior research. Table 1 summarizes the literature.

Table 1: Literature Review of Retention in IS (and STEM) Majors

Independent variable	**References**
Enjoyment/Affect	[Brainard and Carlin 1998; Croasdell et al. 2011; Dennehy and Dasgupta 2017; Giannakos et al. 2017a; Gokhale et al. 2015; Wang 2013]
Career Opportunities	[Brainard and Carlin 1998; Croasdell et al. 2011; Wang 2013]
Quality of Education	[Brainard and Carlin 1998; Giannakos et al. 2017a; Giannakos et al. 2017b]
Social Image	[Brainard and Carlin 1998; Giannakos et al. 2017b]
Grades	[Freeman et al. 2014]
Prior Experience	[Wang 2013; Ware and Lee 1988]
Mentorship	[Campbell and Campbell 1997; Dennehy and Dasgupta 2017]

When students enjoy their math or science classes, they tend to continue to take similar STEM related classes in the future [Brainard and Carlin 1998]. This is especially important for first- or

second-year students who are still trying to decide upon their major. Students who feel that the course is enriching, useful, and fulfilling [Giannakos et al. 2017b] tend to persist in their major. Particular to Information Systems, having a genuine interest/attitude towards Information Systems generates a large impact to help students choose and pursue this degree to completion [Croasdell et al. 2011; Gokhale et al. 2015; Wang et al. 2013].

In STEM related fields and majors, job availability is a factor that piques interest in new freshman exploring the major [Brainard and Carlin 1998]. It entices them to take courses in the major but is not typically an influencing factor to pursue a STEM major after their freshman year. In general for all majors, career advancement opportunities and compensation are significant factors for male students' choice of a particular major [Malgwi et al. 2005]. But interestingly, women who choose to major in Information Systems are instead influenced by the job availability of the field [Croasdell et al. 2011]. Compensation and advancement did not appear to significantly affect the female student's choice of an IS major.

The quality of education can impact the likelihood of a student persisting in a STEM major. A key component of quality education is academic interaction [Wang 2013]. Professors who are open to interacting with their students tend to have a positive influence on students continuing their studies in that field. Interaction with an academic advisor who can help lead and guide students [Brainard and Carlin 1998] will also contribute to a higher quality of education and persistence in a STEM degree. Also, it was determined that poor teaching can lead to a higher chance of students dropping out of a computer science course or degree [Giannakos et al. 2017b].

For Information Systems majors, the decision to major in this degree can be influenced by the social image they acquire by being an Information Systems major [Croasdell et al. 2011]. Students are more likely to decide on persisting in IS as long as they perceive a positive social image of students in the major. For STEM majors in general, a sense of belonging is important for female students to make the decision to pursue that degree [Dennehy and Dasgupta 2017]. Other perceptions of social image such as work-family conflict and social expectations [Ahuja 2002] typically can discourage female students from a degree in STEM.

Grades are an important part of being successful in higher education. To some degree, students attribute bad grades as a reason why they drop a class [Conklin 1997]. Bad grades can lead to lower self-esteem [Crocker et al. 2003], which in turn can dissuade students to pursue a degree, especially female students who are influenced heavily by their aptitude towards a subject [Malgwi et al. 2005]. A professor's teaching style can shape a student's grade with active learning styles having a more positive effect than traditional lecturing [Freeman et al. 2014].

For students to have a desire to pursue a STEM major, often-times prior experience will influence that decision. Sometimes, the prior experience is with influential high school guidance counselors [Ware and Lee 1988] or academic success in math or science classes [Wang 2013]. In some cases, a lack of preparedness can make students feel inept at the subject and potentially drop the course or major but training before the beginning of the course can mitigate this negative effect [Dekhane et al. 2016]. In others, doing well academically in areas other than STEM fields can lead to students having more options for majors, so they might choose a non- STEM major [Wang et al. 2013].

As one may expect, mentorship for female students to pursue a STEM major has a significant impact [Dennehy and Dasgupta 2017]. Both male and female students will generally perform better academically but female students with a female mentor will usually have a better sense of belonging, less anxiety, and desire to pursue further education in STEM. Not having a mentor does not negatively affect a student majoring in STEM but it can certainly help further their education [Dennehy and Dasgupta 2017].

III. Self-Efficacy Theory

Each of these factors examined in prior research (discussed above) can be mapped into a self-efficacy theory lens [Bandura 1977]. Bandura posits that self-efficacy determines the level of effort we will expend on certain tasks. As a result, self-efficacy also affects our performance of these

tasks. In our context, we operationalize coping efforts and performance as a student's persistence in an IS class or program.

Self-efficacy theory broadly defines four antecedents including: 1) Mastery Experience, 2) Vicarious Experience, 3) Social Persuasion, and 4) Physiological States. Mastery experience is the effect that one's performance outcomes has on their confidence in their abilities to perform that specific task. Vicarious experience affects efficacy beliefs when one lacks experience or is uncertain about their own abilities. Instead, they observe others performing similar tasks to gauge their own confidence in performing the task. Social persuasion is the effect that verbal or nonverbal judgement from others can have on one's confidence in their abilities. Physiological states such as excitement, stress, etc. can affect one's confidence in being able to perform a specific task. Figure 1 depicts the overall self-efficacy theory.

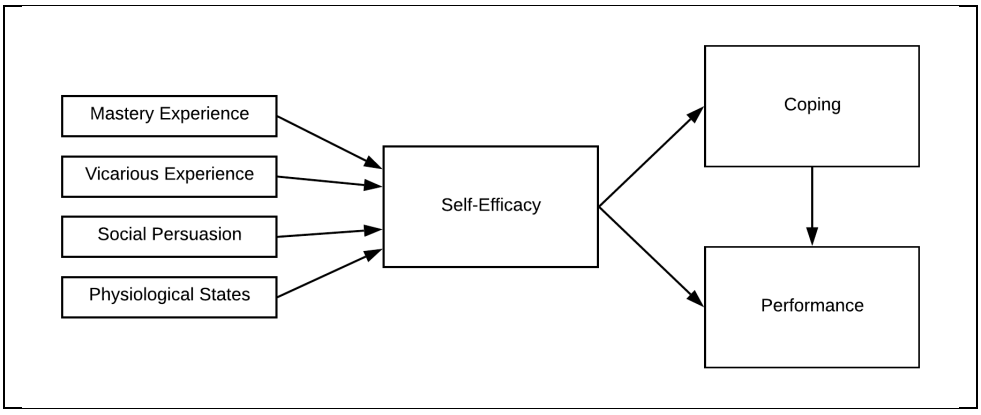

Figure 1. Self-Efficacy Theory adapted from

Self-efficacy has been applied in a variety of IS contexts including computer self-efficacy [Compeau and Higgins 1995], internet self-efficacy [Hsu and Chiu 2004], and mobile self-efficacy [Keith et al. 2015], among many others. In these contexts, greater self-efficacy leads individuals to try harder to complete tasks that require information technology (IT).

However, IS includes more than technology-based self-efficacy alone. In order to deliver IS solutions, professionals and students must also understand the business domain and human processes that draw from IS artifacts [Sidorova et al. 2008]. Furthermore, to be successful at delivering IS solutions, executives have emphasized the need for creative potential in their IS practitioners problems [Couger et al. 1993; Nunamaker Jr et al. 1987; Tiwana and Mclean 2005]. Therefore, we adopt a form of self-efficacy that is more appropriate for the IS domain.

Creative Self-Efficacy

The belief in one's ability to creatively solve unstructured problems is referred to as *creative self-efficacy* [Gong et al. 2009; Richter et al. 2012; Tierney and Farmer 2002]. Most recently, IS researchers have adapted this construct to measure IS creative self-efficacy (CreaSE) which refers to, "*…an individual's belief in their ability to develop creative solutions to new or unstructured business problems through the development of information systems that support business process and the people who execute them*" [Payne et al. 2018, pg. 5].

Based on core theory on human creativity [Hennessey and Amabile 2010], CreaSE is a second-order formative construct with five independent factors [Payne et al. 2018]: 1) affect, 2) business skills, 3) intelligence, 4) people skills, and 5) technology training. *Affect* refers to our emotions, moods, and attitude [Blanchette and Richards 2010] toward creative problem solving which has a significant effect on our creative performance. For example, negative affect can reduce our "flexible

thinking" and problem-solving capabilities on complex tasks [Aspinwall 1998]. *Business skills* is a person's knowledge about the business domain they are working in including processes, strategies, and management. *Intelligence* is the factor that changes the least and refers to the cognitive ability for creativity a person is innately born with. *People skills* is a person's ability to collaborate effectively with others on a team and combine the good ideas from others into their own problem-solving framework. Finally, *technology training* refers to the hard technology skills that a person has, such as programming, data analytics, and computer systems, which will be combined and implemented in creative ways to solve IS problems.

CreaSE is an application of self-efficacy theory [Bandura 1977] in the context of creative problem solving. Therefore, the theorized outcomes drawn from that theory include coping efforts and task performance which can be mapped directly to our context. Self-efficacy theory explains that when people tend to avoid situations in which they feel their coping skills are inadequate. Thus, our focus is on the persistence in an IS program which is an example of a coping effort in self-efficacy theory [Bandura 1977].

CreaSE has been positioned as a primary outcome variable measuring the effectiveness of IS students and practitioners [Payne et al. 2018]. However, we position CreaSE, in this paper, as an antecedent of success in an IS program—measured as a student's persistence in the major. Therefore, we base our theoretical model on CreaSE as the primary lens and hypothesize that it will explain student retention (H2) and be determined by the amount and sources of help that a student receives in an IS course(s) (H1). We do not operationalize the CreaSE prerequisites of *education* and *experience* because each of our samples will come from students who are in approximately the same stage of life with similar levels of education and experience.

In addition to CreaSE, we also measured another important covariate: career priorities. Priorities refer to the qualities that a student prefers in their career: financial compensation, potential to contribute to society, and the desirability of the work schedule in a typical IS role. Lastly, and just as importantly, we also explore differences in gender across each of the variables. Figure 2 visualizes our theoretical model.

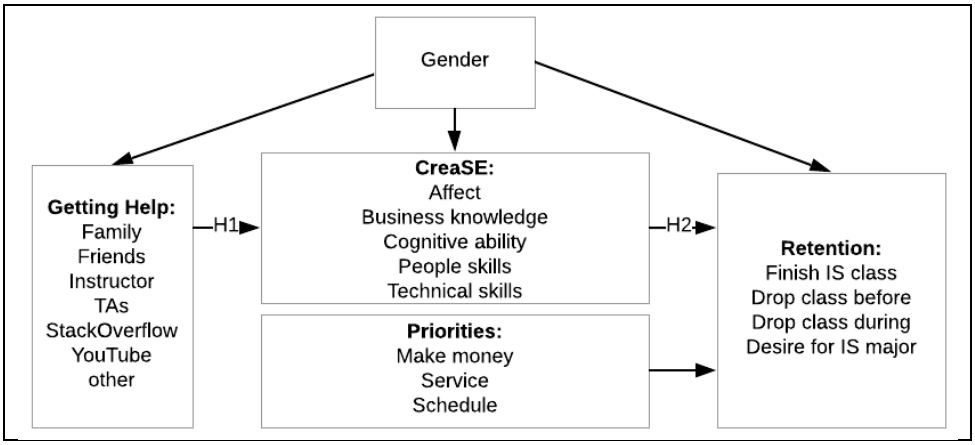

Figure 2: Theoretical Model

IV. Methodology

To explain why a student persists in the IS major, we used a survey methodology to collect data from all students of an introductory programing course in the IS program of a large private university in the western US. Surveys have frequently been used as a means to develop theory, thus our selection of this methodology in this study [MacKenzie et al. 2011]. The sample included 210

responses from two semesters (18 percent female). This sample however is fairly limited due to only collecting response from one university. We collected information on the demographics of these individuals such as age and race but both proved to be insignificant indicators for the purpose of this research. The course was carefully selected because it is the second course in a sequence of pre-requisites to the IS program at this particular university. This means that there are three primary outcomes of interest: 1) students who completed the entire course, 2) students who dropped the course, and 3) students who registered to take the course after or during the prior IS prerequisite, but dropped the course of interest before the first day of class. In addition, we collected a single-item measure indicating (on a Likert scale) how much the student intended to complete a degree in IS (see Figure 2). The CreaSE measurement scale was drawn from prior research developing a validated instrument [Payne et al. 2018].

To eliminate response bias, students who finished the survey were given a $10 Amazon gift card. The initial dataset had a total of 210 records. After removing uncompleted survey responses, the result was 182 usable records.

V. Results

The theoretical model was tested using a partial least squares (PLS) structural equation model (SEM) using the tool SmartPLS 3.2.8 [Ringle et al. 2015]. Path coefficients were calculated to estimate the theoretical relationships. A bootstrapping procedure (1000 sub-samples) was used to estimate the significance of the paths. R squared values representing the amount of variance explained in each endogenous variable are included on the construct symbols in Figure 3.

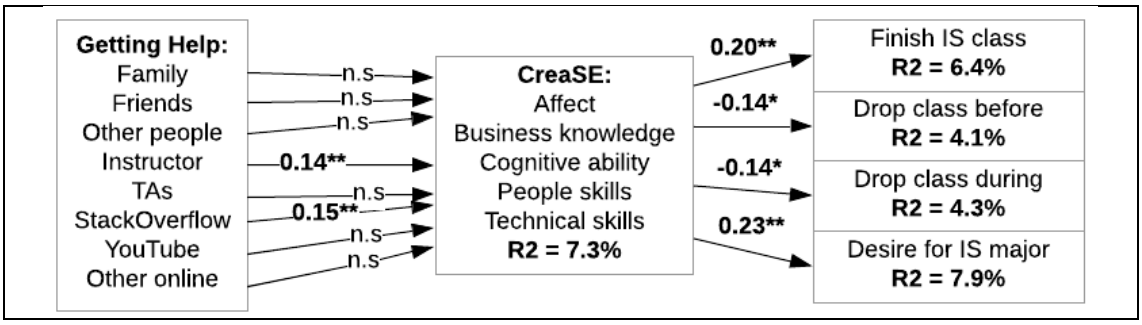

Figure 3: PLS Analysis of Relationships

The results indicate that CreaSE has a positive effect on their desire to major in IS ($\beta = 0.23$, $p < 0.01$) and their likelihood of finishing the pre-requisite course that was the focus of this study ($\beta = 0.20$, $p < 0.01$). It also reduced the likelihood of dropping the course before ($\beta = -0.14$, $p < 0.05$) or after ($\beta = -0.14$, $p < 0.05$) the semester began. We did not display the effect of career priorities in Figure 3 because none of the relationships were significant. Table 2 summarizes the results of a PLS analysis examining the effect of gender on each of our study measures and constructs.

The gender effects in our analysis were stark. Men had a higher likelihood of finding help for the IS course from StackOverflow.com, family members, other people, and other online resources. Men had a higher focus on financial rewards as a priority for their career while women were more concerned with making a positive impact on society (Priority: Service). Additionally, men had higher CreaSE in their technology skills, cognitive ability, business knowledge, and affect. However, women were more confident in their people skills, but it was not significant. Implications of these results are discussed later.

Table 2: Path Coefficients and Significance Estimates for the Effect of Gender

Relationship	*β*	*STDEV*	*T Statistic*	*P Value*
Gender -> help_stackoverflow	0.159	0.074	2.152	**0.016**
Gender -> help_otherpeople	0.148	0.051	2.924	**0.002**
Gender -> help_otheronline	0.107	0.074	1.44	**0.075**
Gender -> help_instructor	0.006	0.082	0.076	0.470
Gender -> help_friends	-0.066	0.11	0.6	0.274
Gender -> help_family	0.105	0.06	1.747	**0.041**
Gender -> help_YouTube	0.020	0.076	0.255	0.399
Gender -> help_TAs	-0.026	0.086	0.301	0.382
Gender -> Priority: Service	-0.112	0.055	2.053	**0.020**
Gender -> Priority: Schedule	-0.062	0.075	0.824	0.205
Gender -> Priority: Money	0.247	0.071	3.477	**0.000**
Gender -> Finished Course	0.211	0.089	2.365	**0.009**
Gender -> Dropped Before	-0.214	0.091	2.353	**0.009**
Gender -> Dropped During	-0.04	0.09	0.451	0.326
Gender -> Desire for IS Major	0.087	0.082	1.07	0.142
Gender -> CreaSE_SK	0.192	0.069	2.793	**0.003**
Gender -> CreaSE_PE	0.042	0.065	0.646	0.259
Gender -> CreaSE_CA	0.202	0.08	2.514	**0.006**
Gender -> CreaSE_BK	0.194	0.072	2.701	**0.004**
Gender -> CreaSE_AF	0.177	0.078	2.25	**0.012**

VI. Discussion and Conclusion

In summary, student retention and gender differences in the Information Systems major can be addressed by increasing CreaSE in students. Our results demonstrate that along with known retention factors (e.g. affect, career opportunities, quality of education, etc.), CreaSE has a positive effect on a student's desire to major in IS and is a significant indicator of student retention in IS majors. As students have more confidence in their ability to solve business problems with IS solutions, their self-confidence and self-worth perceptions can be elevated, resulting in students more likely to major and persist in IS. It also can reduce the likelihood of dropping the course before it even begins and help students see the course through completion.

The majority of students that dropped the IS course before it even began were female students while the majority of students that completed the IS course were male students. We found that various factors contribute to the development of CreaSE in students. Students that sought help from the instructor or Stack Overflow showed a significant increase in CreaSE compared to those that did not. We also found that women's help-seeking proved insignificant for the development of CreaSE. Additionally, gender proved to be a significant indicator of CreaSE. While women were more confident in their people skills, men showed higher scores on all other CreaSE factors.

This lack of self-confidence and self-worth perception in women is a potential theory as to why women are more likely to drop IS courses and feel as though they cannot be successful in the IS major. We recognize that this study is limited by the small portion of women represented. This is due to gender discrepancies prevalent in IS programs. An increased proportion in women in the sample can lead to greater insights on balancing the gender ratio. Clearly, more research needs to be completed on how Crease is formed in students.

Implications

The increase of CreaSE in a student is a key factor to improve retention and draw more students to Information Systems. This suggests that if an Information Systems course could build CreaSE in students, especially females, there is a greater chance to retain those students in the major and

increase the number of students choosing to study Information Systems. Thus, another change that could prove beneficial to an Information Systems program is to focus on those aspects of CreaSE that women seem to be lacking in a STEM major, mainly building confidence in their abilities. When professors consider how coursework specifically helps students develop CreaSE, they can create a better environment for men and women alike to learn and gain confidence, ultimately feeling more comfortable in their pursuits in IS.

We know that Stack Overflow can be a beneficial help to promote retention for our students who apply for and enroll in an Information Systems program, largely due to students having to read and learn. One potential change is to collect metrics after each assignment to identify potential students who may drop the course. Actively supporting the use of Stack Overflow and other online resources during in-class lectures may provide positive outcomes to help students learn how to learn independently. When students learn methods of teaching themselves, they can feel positive and confident about their future abilities within their major.

Future Research

At this point, the dataset that we have collected is fairly small, and it would be beneficial to collect more survey data. Our models could then be trained further and possibly more significant variables may emerge, especially pertaining to female students. The survey administered to the program can also be revised to focus on questions that may be more pertinent to the study, removing personality or other questions that have virtually no significance on our retention/drop rates. We are also gathering data for current retention factors to discover and confirm gender-related retention factors.

Another idea is to communicate with students before the course begins. Once a student registers for the course, the instructor can send an email welcoming a student thus beginning the interaction before the first day of lectures begin. This could help establish a mentorship environment and open communication that could potentially reduce student anxiety. In the welcome email, part of the content could disseminate past grade averages, job placement history for past Information Systems students, and other information about the major including service opportunities and compensation.

Through the implementation of establishing lines of communication before the course even begins, we'd also hope to further uncover why women are less likely to seek help and be able to address that issue. If an instructor can show availability to everyone in the course in addition to highlighting possible external resources, women would hopefully feel more comfortable using those sources that have previously proven to have a positive correlation with CreaSE.

One more idea is to discover other sources of help that might have greater appeal to a student based upon gender. Possibly looking at virtual assistants such as Alexa and programming a bot for custom responses in a cloud-based collaboration hubs such as Slack.

An important key discussed in this research is the relevance of CreaSE in student retention; however, the research on how to actually change CreaSE is limited. While Payne, et al (2018) establish clear antecedents to CreaSE, these have not been expounded upon to practice. Therefore, there is substantial room for research on what actions could be established in the classroom for students to feel more confident in their own abilities and, consequently, their ability to succeed in the Information Systems major.

This research modeled CreaSE as a single second-order constructor. Future research should separate CreaSE into its distinct subcomponents which differentiate IS from other STEM fields. While this research is a good first step towards understanding student retention in the IS domain, future research can expand on this by demonstrating how getting help is unique across the subcomponents of CreaSE.

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VIII. APPENDIX A: EXCERPT FROM SURVEY INSTRUMENTS

Which of the following describes your experience?	I registered for *Introduction to Computer Programming*, but I decided to drop the course before attending a class session I began taking *Introduction to Computer Programming*, but I decided to drop the course after attending one or more class sessions I began taking *Introduction to Computer Programming*, but I decided to drop the course. However, I completed (or plan to complete) the course in a later term or semester. I completed *Introduction to Computer Programming*
What is your gender?	Male Female
Please indicate your level of agreement with the following statements (CreaSE) (7 point scale)	
I believe that I would be afraid of having to create new solutions to business problems.	
I believe that I would have the determination necessary to creatively solve business problems.	
I believe that creative business problem solving would be very interesting to me.	
I believe that I would be enthusiastic about creative business problem solving.	
I believe that creating new business solutions would cause me distress.	
I believe that I have the domain knowledge necessary to identify the root cause of a business problem.	
I believe that I have the expertise necessary to solve complex business problems.	
I believe that I have enough knowledge about business process to create better solutions.	
I believe that my knowledge of business strategy would help me creatively solve problems.	
I believe that I have the ability to learn emerging technologies that can solve business problems.	
I believe that I have the ability to think through business problems logically.	
I believe that I have the ability to understand a business problem from multiple angles.	
I believe that I have the ability to think unconventionally to find business solutions.	
I believe that I have the mental capacity required to understand the root cause of a business problem.	
I believe that I understand why people respond the way they do to new business ideas.	
I believe that I understand how people will react to changes in business processes.	
I believe that I understand how people will interact with new technology.	
I believe that I understand how people operate within a business environment.	
I believe that I have the data collection skills necessary to create business solutions.	
I believe that I have the data analysis training required to create unique business solutions.	
I believe that I have the information technology skills necessary to create new business solutions.	
I believe that I have the leadership training required to implement creative business ideas.	
If you are paying attention, please select "Strongly agree" for this statement.	

IX. About the Authors

Peter Garrow is a graduate student in Brigham Young University's Masters of Information Systems Management Program. His research has focused on gender and self-efficacy in Information Systems students. He is interested in further research in the fields of human-computer interaction and technological education.

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Alexandra N Spruill is a graduate student in Brigham Young University's Masters of Information Systems Management program. She has previously published numerous conference papers at HICSS, including a Best Paper Award winner. Her research has largely been focused on team dynamics, gamification, and creative self-efficacy in IS professionals and students. Alexandra is currently applying for Ph.D. programs for the following academic school year.