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Communications of the Association for Information Systems

The Absence of Gender Differences Among Students in an MIS Program

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Abstract:

The declining proportion of women in the IT profession contributes to the shortage of IT professionals and potentially has a detrimental effect on the success of design projects. However, we do not fully understand why that decrease is happening. Some studies have utilized a construct called *stereotype threat* to explain why women are rejecting IT as a profession. Others have claimed that the results of stereotype threat apply only in computer science programs housed in engineering schools. This study tests whether stereotype threat exists in an MIS program in a college of business and, if so, how it affects women's confidence in their ability and motivation to continue their IT education. The results show no support for the stereotype threat hypothesis. Further analysis, however, shows that *positive, supportive* messages have more effect on these women than do the negative messages. Thus, while stereotype threat has been a successful model for explaining the behavior of women in the sciences, mathematics, and computer science, it does not appear to explain the decreases in the number of women in MIS programs in business schools. A discussion of the aspects of MIS programs that may attract women and possible ways to increase women are provided.

Keywords: IT professional, IS recruiting, IS teams, women, group projects

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I. INTRODUCTION

Much has been written about the declining percentage of women in the IT¹ profession during the last twenty years (see, for example, Ashcraft and Blithe, 2009; Clow, 2002; Cohoon and Aspray, 2006; Cooper and Weaver, 2003; DuBow, 2011; Harris, Kruck, Cushman and Anderson, 2009; Hill and St. Rose, 2010; Joshi and Schmidt, 2006; Nafus, Leach, and Krieger, 2006; NSF, 2008; Randall, 2003; Simard, 2007; Teague, 2002). Although there are some examples of women who have excelled in the field, such as Ginni Rometty and Carly Fiorina, they are the exceptions. The percentage of women in IT jobs in the United States is only 20–26 percent (compared to 35–40 percent in 1987), while less than 10 percent of senior programmers in the United Kingdom are women [Clements, 2002; DuBow, 2011; NSF, 2008; Simard, 2007; Swain, 2003]. Similarly, there has been shrinkage in the percentage of women seeking IT education. For example, in 1984, 37 percent of computer science undergraduates were women, compared to less than 20 percent now [NSF 2008]. The number of women taking the advanced placement computer science test fell from 17 percent in 1987 to 14 percent in 2002, and then to 12 percent in 2006 [DuBow, 2011; Hill and St. Rose, 2010; McCarthy, 2003]. Overall, women now earn only 27 percent of the bachelors' degrees and between 10–16 percent of the doctorates in IT [Clow, 2002; DuBow, 2011; Dyrness, 2002; Hill and St. Rose, 2010; NSF, 2008; Randall, 2003]. Only 8 percent of recent patents addressing computer software were from teams including a woman [Ashcraft and Breitzman, 2007]. Further, less than 2 percent of open source developers are women [Nafus et al., 2006]. The message is consistent across levels of experience and across studies: fewer women seem to be opting for education and careers in IT today than in recent history [DuBow, 2011; Hill and St. Rose, 2010; Himmelsbach, 2008; Lang, 2007; Simard, 2007].

This decreasing number of women in the field clearly contributes to the overall gap between the supply of, and demand for, IT professionals [Akbulut-Bailey, 2009; Ashcraft and Blithe, 2009; Camp, 1997; Harris et al., 2009; Simard, 2007; Teague, 2002; Trauth, 2002]. In addition, this decreasing participation by women can also contribute to *how* IT responds to the needs of businesses and society. For example, both the disproportionately large number of men and their seniority in the IT sector foster a bias toward male viewpoints dictating product development, the process of development, the design of new technology, and, ultimately, the relative usefulness of new technology to all users [Ashcraft and Blithe, 2009; Doty, 2002; DuBow, 2011; Fouad and Smith, 2008; Jones, 1991; Kirkpatrick, 2002; Schmader, 2004; Schoenberg, 2001; Shor, 2002; Teague, 2002; Trauth, 2008]. Some research suggests that increasing the number of women in development teams can contribute to improved success in design and management of IT projects [Ashcraft and Blithe, 2009; Ashcraft and Breitzman, 2007; Gunson and Fielder, 1991; Hill, Corbett, and St. Rose, 2010; Simard, 2007; White, 1984; Whoolley and Malone, 2011]. In this field, where the demand for applications grows every day and the probability of project failure has been estimated to be well above 50 percent, the IT community should be eager to pursue any path that might improve its ability to meet demand successfully [Johnson, 2006]. In other words, it is in society's best interests to increase the number of women in the IT field [Ahuja, 2002; Ashcraft and Blithe, 2009; Hill et al., 2010; National Academies, 2007; Teague, 2002]. In fact, some have said increasing the numbers of women in IT is critical to maintaining national competitiveness [National Academies, 2008; Simard, 2007].

There are a number of reasons why women do not seek and/or why they do not stay in the IT field. These reasons have been documented in the literature and range from aptitude and interest to experience and confidence (see, for example, Ahuja, 2002; Aronson, Quinn, and Spencer, 1999a; Ashcraft and Blithe, 2009; Clements, 2002; Cooper and Weaver, 2003; DuBow, 2011; Frenkel, 1990; Harris et al., 2009; Simard, 2007; Teague, 1997; Trauth, 2002; Trauth, 2008). One of the reasons proposed to explain why women do not pursue IT careers in the literature is the fear of stereotypes [Akbulut-Bailey, 2009; Bell, 2003].

The concept of stereotype threat was first introduced to explain results from a study of women and mathematics performance (see, for example, Steele, 1997; Spencer and Steele, 1994; Steele, Spencer, and Lynch, 1993). "Stereotype threat," which is sometimes referred to as *stereotype vulnerability*, is a fear that one will be judged or treated in terms of a negative stereotype of one's group. It is experienced by individuals who generally are a minority in a field and who, as a group, are frequently reminded of their alleged ineptness in the field of study. When faced with a task, individuals experience anxiety to perform well (because anything else would reflect badly on the

¹ The term *IT* is used throughout this article to encompass information technology, information systems, computing, and related careers.

person's group), which, in turn, causes the individual to perform less well simply because of stress [Aronson et al., 1999a; Aronson et al., 1999b; Bell, 2003; Cadinu, 2005; Osborne, 2001]. For example, in the study introducing the concept of stereotype threat, researchers performed a number of experiments on highly skilled and motivated mathematics students, whose expectations they manipulated. When told they would have difficulty, female students performed poorly and reinforced the stereotype. However, when not reminded of the stereotype and encouraged on the test, women performed the same as men [Steele, 1997]. A similar result was identified by Spertus [1991] who found that women (but not men) in male-dominated scientific fields perceive and internalize fundamentally lower expectations for themselves. Ongoing discrimination, even if it is subtle, was found to erode self-confidence, especially when coupled with the absence of encouragement, exposure to female-unfriendly environments, and reinforcement from the media [Aronson et al., 1999a; Chisolm et al., 1999; Clarke, 1992; Hemmingway, 1995; Mah, 2002; Martin, 1992; Reinen and Plomp, 1997; Wellhousen and Yin, 1997].

Further, Valian [1998] found that even when no one *explicitly* disapproves of the group's performance, women (but not men) in male-dominated fields tend to apply the negative stereotype that they have internalized. In fact, Steele and Aronson [1995] found that "the existence of such a stereotype means that anything one does or any of one's features that conform to it make the stereotype more plausible as a self-characterization in the eyes of others and perhaps even in one's own eyes" (p. 797). So, the stereotype fear can interfere with individuals' task performance and may even reduce commitment to (sometimes total loss of interest in) a career in that field [Beyer, Rynes, Perrault, Hay and Haller, 2003; Irani, 2004; Steele, 1997].

Stereotype threat has been shown to impact any minority faced with repeated negative images of their abilities (*including white males*—when compared to Asian males in mathematics ability) [Aronson et al., 1999b]. There is significant literature that provides evidence of stereotype threat as an explanation for women not pursuing or not excelling in science [Chisholm et al., 1999; Hemmingway, 1995; Mah, 2002; Reinen and Plomp, 1997; Stake and Mares, 2001; Wellhousen and Yin, 1997]. There is also work that documents the applicability of the Theory of Stereotype Threat in the area of information technology. Fischer, Margolis, and Miller [1997] and Margolis and Fischer [2002] have documented that stereotype threat has contributed to female students' decisions, but not to comparable male students' decisions, to change *from* a computer science major at Carnegie Mellon University. Further, they and others have documented that women computer science students who *stay in* the major also experience negative effects on performance and motivation. Other studies note similar effects [Himmelsbach, 2008; National Academies, 2007; Schoenberg, 2001].

However, Ogan, Robinson and Ahuja [2006] question whether the problem of stereotype threat provides a uniform barrier to women pursuing IT education or if the results seen in the literature are associated with the "culture represented in [engineering schools]" (p. 280). They note that there are other disciplines in which IT is taught, including Information Systems in a College of Business, that differ in the demographics, computing experiences, behaviors, and attitudes from computer science departments. Ogan's team found some preliminary evidence that those differences have some impact on women pursuing a career in IT. Similarly, Randall [2003] and Woszczynski, Myers, and Moody [2006] provide some evidence that IT programs outside of an engineering schools provide environments that are more favorable for women interested in IT.

The question may be more complicated in Information Systems programs because of their reliance on cooperative learning strategies, generally experienced as group projects. Cooperative learning strategies have become increasingly popular in MIS programs, both to allow students to consider more complex applications and to help students develop useful professional skills. When the group project works as planned, there is a strong cohesion among group members resulting from mutual respect, trust, and acceptance of one another. This, in turn, leads to increases in confidence in their abilities generally and in their potential to achieve their desired career goals [Budman et al., 1989; Malkin and Stake, 2003; Yalom, 1995]. Hence, in the absence of any conflicting factors (such as stereotype threat), successful completion of the cooperative learning task (group project) should lead to increases in both a student's confidence in his/her ability and his/her motivation to pursue a career in IS.

Such interaction can lead to negative student outcomes as well. Some studies suggest negative exchanges can lead to perceptions of *not* being trusted or respected by their classmates, which can lead to the student taking less positive lessons from the experience [Astin, 1993; Stake and Hoffman, 2001]. Although the negative experiences would affect all students, according to the Theory of Stereotype Threat, they would impact women to a greater degree and would decrease their confidence in their ability and motivation to pursue MIS further. In particular, any male negative attitudes about women's role in the IS field would be exacerbated by cooperative learning strategies.

This study responds to the call for more research to understand the impact of stereotype threat on women pursuing collegiate programs in IT outside of engineering schools. Specifically, this study examines attitudes in an MIS

program which is located in a college of business, as well as the impact of cooperative learning strategies on those attitudes.

II. MODELS

This study does not intend to document whether or not stereotyping of women in IT occurs in American society. It is impossible to account for and measure all the possible sources of stereotyping that have influenced people from birth until the time that they are enrolled in an information systems (IS²) program. Further, it is impossible to measure the extent to which such messages about stereotypes might be internalized by an individual or group of individuals. Hence, this study will follow the methodological precedent in the literature and will not attempt to measure the existence of stereotype threat directly.

Instead, this study, following the precedent in this research stream, will look at the attitudes of the men in the program as a surrogate of stereotype threat experienced by the women in the class. The literature would predict that women in an IS program would run the risk of stereotype threat if they are a minority in the discipline, and if the men with whom they interact do not believe women should be in IS. Since women are a minority in the field of IS, the surrogate measure of male students' "Attitude Toward Women in IS" (ATWIT) will be used to establish the level of hostility or acceptance that exists for women in the program. The literature predicts that stereotype threat will decrease women's self-confidence in their ability to perform satisfactorily in, and their commitment to, careers in IS. This basic model is illustrated in Figure 1.

Negative male attitudes can have an indirect impact on the confidence and commitment of the women also. A negative attitude toward having women in a group can affect the level of cohesion in the group. In turn, when cohesion in the group is low, the literature suggests team members will have more negative exchanges, which will, in turn, cause them to question their own abilities and commitment to the project. Similarly, a negative outcome in the task, such as represented by a bad grade on the (team) project, can also decrease students' confidence in their abilities and commitment to careers in IS. These relationships are shown in Figures 2 and 3.

² The use of the term IS means we speak specifically of IT programs housed in colleges of business. These programs generally are called Information Systems (IS) or Management Information Systems (MIS) programs.

If these factors are amassed into one model, it would appear as in Figure 4.

Figure 4. Total Model of Confidence and Motivation

Figure 4 illustrates that a student's confidence and motivation at the end of the semester ($confidence_T$ and $motivation_T$) is a function of the confidence and motivation, respectively, that he or she had at the beginning of the semester ($confidence_0$ and $motivation_0$), but this direct relationship can be changed by a number of things along the way. For women, both their confidence and their motivation can be decreased directly by being in a group that has negative attitudes about women in IT. Such negative attitudes about women in IT can also have a negative impact on group cohesion which would indirectly decrease a woman's confidence and motivation. Without such a negative effect, good cohesion could improve a student's confidence and motivation. Likewise a good task outcome, such as a high score on a project, could also increase confidence and motivation. Finally the student's confidence at the end of the semester ($confidence_T$) could impact her motivation to pursue the major further ($motivation_T$).

III. METHODOLOGY

Subjects

This research examined behavior of students in nine IS classes in an MIS program at a state university during one academic year. Two of the classes were at the masters' level and seven of the classes were senior (undergraduate) level. These classes were chosen because of their reliance on team projects for a large portion of the grade and effort during the semester. Unlike traditional classes, these classes require students to have significant interaction with others to complete necessary assignments; students were in the same groups for the entire semester in these classes. Further, the structure of the classes required that each student be dependent on others in his or her group to be able to accomplish the task. Finally, this interactive project accounted for a *significant portion* of the graded work in the class.

Researchers measured students' attitudes and behaviors at the beginning of the semester (time 0) and at the end of the semester (time T).

Measurement Scales

To operationalize the concepts (attitude toward women in IT, confidence in one's IT abilities, motivation to pursue a career in IT, and group cohesion), the researcher adapted self-report instruments for each of the four model constructs from instruments introduced and validated in the literature. The adaptation involved minor word adjustment to change the focus from "science or mathematics" to "information technology" for each item. In addition, the researcher recorded student-provided demographics such as age, gender, race, program of study, and past work experience, as well as their project grade. All instruments are included in the appendices.

First, the Attitudes Toward Women in IT Scale (ATWIT) was adapted from the Attitude Toward Women in Science Scale³ [Erb and Smith, 1984], which taps perceptions of gender differences in ability to achieve in science [Erb and Smith, 1984; Stake, 2003]. It has been used in several studies and has shown evidence of good test-retest reliability,

³ This scale, as well as all of the data collection scales, is included at the end of this article.

discriminant validity, and internal consistency (with $\alpha \geq .70$). The scale was composed of six questions regarding the subject's attitudes toward professional women in the IS field. Subjects were asked to mark the degree to which they agreed with the statement, using a seven-point Likert scale. Four of the statements were phrased to affirm women's roles in IT, while two were phrased negatively toward women's roles in IT. The corrected scores on the ATWIT scale ranged from 6 to 42. Thus, a corrected score of 6 represented a person who always answered strongly negatively toward the concept of women in IT, and a corrected score of 42 represented a person who always answered strongly positively toward the concept of women in IT. In this study, measures of internal consistency were acceptable at pre-testing ($\alpha = .77$) and at post-testing ($\alpha = .76$).

Students also completed instruments that measured their motivation (for careers in IT) and confidence (in their abilities). These two measures were adapted from parallel measures of science confidence and motivation that have good internal consistency (with $\alpha \geq .70$) and evidence of discriminant validity. Career motivation was assessed with a 5-item measure adapted from the Motivation for a Science Career Scale by changing "science" to "information technology" [Stake and Mares, 2001]. Measurement of confidence was adapted from the Science Self-Concept Scale [Campbell, 1991; Stake and Mares, 2001]. Again, the modification involved simply changing the key term from *science* to *information technology*. In this study, measures of internal consistency for career motivation were quite good, with $\alpha = .91$ at pre-test and $\alpha = .90$ at the post-test. Measures of internal consistency for confidence in this study showed acceptable internal consistency, with $\alpha = .76$ at pre-test and $\alpha = .77$ at post-test.

Finally, the cohesion measures were adapted from a scale developed and validated by Malkin and Stake [2001], who extend the traditional concepts of group cohesion developed for psychotherapy groups [Yalom, 1995] to a scale that is appropriate for a college setting. This 16-item measure of cohesion has shown high internal reliability ($\alpha = .93$) and discriminant validity in the college setting [Malkin and Stake, 2001]. The questionnaires were composed of four primary scales, each measured on a seven-point Likert scale, with both positive and negative anchors, to examine different aspects of cohesion. In this study, the internal reliability was $\alpha = .85$ at pre-test and $\alpha = .87$ at post-test.

Team Measures

While the class experience as a whole can impact individual students, the one-on-one experience in teams may have an additional, or even different impact on a woman's confidence (in her IT abilities) and her motivation (for a career in IT). Thus to check the influence of the small team experience, the analyses were repeated using a *team* ATWIT score to predict confidence and motivation. This "team score" represents a surrogate measure of the atmosphere experienced by an individual in the team setting. Such an atmosphere can be represented in different ways, so three measures were considered: (1) the average ATWIT score of the members of the team (T-AVG), (2) the maximum ATWIT score of the members of the team (T-MAX), and (3) the minimum ATWIT score of the members of the team (T-MIN). These three values then represented different aspects of the specific, day-to-day experiences regarding team members' attitudes toward women in IT; they represented the typical attitude, the most female-positive attitude, and the least female-positive, respectively. The three measures of attitude at the beginning of the project (T-AVG₀, T-MAX₀, T-MIN₀) and the three measures of attitude at the end of the project (T-AVG_T, T-MAX_T, T-MIN_T) were used to predict confidence and motivation of male and female subjects separately.

The literature clearly suggests that women will be more confident in their abilities and more motivated to study IT if they are in teams with people who are supportive of women in IT. However, it is not clear when that effect is realized. That is, it is not clear whether it is the score at the beginning of the semester, when teams begin to coalesce, or the score at the end of the semester, representing the culmination of the experience, that is more relevant to predicting women's confidence and motivation at the end of the semester. Hence, both measures were examined. However, the literature does not predict that support of women in IT will have any impact on male students.

Measurements were taken at both the beginning (pre-test; time 0) and end (post-test; time T) of the semester for Attitudes Towards Women in IT, Confidence, and Motivation. Team cohesion was measured after the teams were identified and work first began (time 0) and then again after projects were completed at the end of the semester (time T).

Task outcome was measured only at the end of the semester; it was the term project grade. This measure was a typical grade on a scale from 0–100 assigned by the professor, representing the quality of the project output. The uncorrected grade reflected the completeness and accuracy of several identified components, as well as the quality of the presentation. All team members received the same uncorrected grade. The corrected grade included an adjustment of the uncorrected grade which reflected each student's participation and contribution to the project. This correction was obtained based on point distribution recommendations made by each member of the team. Analyses were completed with both the uncorrected and corrected grades.

IV. RESULTS

Of the 309 subjects, 273 (88 percent) were juniors or seniors pursuing an undergraduate degree, and thirty-six (12 percent) were masters' students. A significant minority (40 percent) of those undergraduates who responded indicated their age was greater than traditional college age (eighteen to twenty-two years for undergraduates), and about 30 percent of the group had previous full-time work experience. About 26 percent of the students were people of color, and 18 percent of the students were foreign-born. Approximately 38 percent of the students were women. Although this percentage was higher than proportions reported in the literature,⁴ it is consistent with enrollments at this institution.⁵

The model shown in Figure 4 was tested using hierarchical regression analysis. ATWIT, gender, and their interaction were tested as predictors of cohesion. In addition, cohesion, gender, and their interaction were tested as predictors of IT motivation and confidence at post-test. The hierarchical regression analysis was not significant, suggesting the model was not supported. That is, the statistical test did not provide evidence that women's confidence (in their IT ability) and motivation (to pursue an IT career) were not affected by ATWIT, group cohesion, and task performance, as shown in Figure 4. Since the model was not supported, the researcher did some additional post-hoc testing to explain the absence of results. These are presented in the remainder of this section.

Attitudes Toward Women in IT (ATWIT) Scale

Overall, the subjects in this experiment scored an average of 33.01 (s.d. = 5.32) on the ATWIT scale at the beginning of the semester, and 33.39 (s.d. = 5.94) at the end of the semester. These scores are broken down by gender in Table 1.

The difference in scores between men and women was statistically significant ($p \leq .05$) for both the pre-test *and* the post-test measurements. On average, women were more positive about women in the IT profession than were men. The male subjects, however, were also quite positive. The average ATWIT score for men was well above the scale midpoint (24) and in the generally "positive" range of the scale. So, although these data support the expectations of the literature, that women would be more positive toward increasing the number of women in IT than would men, the men's scores were remarkably high. In fact, the average men's score is higher than one would expect from the literature.

Table 1 also reports that ATWIT scores increased over the course of the semester for both men and women, although the increase was not statistically significant. This might suggest that the people become more comfortable as they get accustomed to working together or it might simply be a statistical curiosity. But it is something that deserves follow-up in future studies.

Table 1: Overall ATWIT Averages

	Beginning of Semester Mean (sd)	End of Semester Mean (sd)	Within Group Change over Semester
Women	34.38 (4.99)	35.34 (5.64)	n.s.
Men	31.86 (5.36)	32.17 (5.27)	n.s.
Total	33.01 (5.32)	33.99 (5.94)	
Between group difference	$p < .05$	$p < .05$	

Motivation and Confidence Scales

Table 2 summarizes the analysis for the motivation and confidence scales. On the motivation scale, both men and women scored, on average, slightly above the midpoint of the motivation (for pursuing a career in IT) scale, with no

⁴ National statistics do not differentiate between those in MIS programs and those in computer science programs. In fact, there can be significant overlap between what is considered MIS and computer science. The gender patterns in the computer science program at this state university parallels those of the national trends. This suggests there is not an obvious reason to suspect the same patterns might not be observed elsewhere. Furthermore, these differences in relative representation of women in MIS and in CSc will help guide our explanation of the results.

⁵ Since its inception in the early 80s, the MIS program at this institution has averaged an enrollment of about 42 percent women at the undergraduate level, and about 40 percent at the graduate level.

statistical difference between the groups. Female subjects' scores increased slightly over the course of the semester, but the difference was not statistically significant. This is not consistent with the expectations if stereotype threat is present. For example, studies such as Steele [1997] and Margolis and Fischer [2002] predict women's motivation for a career in the IT field would be lower.

The average male scores are statistically significantly larger than the female scores on the confidence scale both at the pre-test and post-test; this is expected from the literature.⁶ However, even the men in this study were only of average confidence in their abilities, which is probably reasonable, given they are students who are only about half-way through their preparation for their career.

As expected, the male confidence scores increased over the course of the semester, as measured by paired t-tests. The increase in confidence among the men was expected since they had successfully solved actual problems for real clients. Certainly, it is a much different experience than well-defined and well-specified problems with which they were familiar, and should have boosted their confidence.

Female students also showed an increase in confidence in their abilities over the semester, but the paired difference change was not statistically significant. More importantly, the cooperative learning environment did not impact women negatively, as one would expect if stereotype threat were present. In fact, while there was a statistical difference in confidence between men and women at the beginning of the semester, there was no such difference at the end of the semester.

Surprisingly, term project grade was not a good predictor of the increase in confidence or motivation (for a career in IT) for either male or female subjects. In other words, the success of the project (in terms of grade) did not have an impact on confidence or motivation; simply experiencing and completing the project appears to be important.

Team Impact on Confidence and Motivation

In an attempt to understand the relationship between ATWIT and both motivation and confidence better, the data were also examined at the team level. As stated earlier, the lowest ATWIT score within the project group, the average ATWIT score within the project group, and the highest ATWIT score within the project group were recorded both at the beginning of the project and at the end of the project and associated with each subject's record. These group-level scores reflect the ATWIT of the least supportive member of the team (ATWIT-MIN), the ATWIT of the *average* level of support of members of the team (ATWIT-AVG), and the ATWIT of the *most* supportive member of the team (ATWIT-MAX), respectively. These measures are believed to represent the extremes and the centrality, respectively, of supportiveness within the individual group for women in IT.

Table 2: Motivation and Confidence Results					
Scale	Possible		Group	Pre-test Mean (sd)	Post-test Mean (sd)
	min	max			
<i>motivation for a career</i> motivation	5	35	women	26.62 (6.18)	27.82 (6.33)
			men	27.68 (5.96)	27.30 (6.06)
<i>confidence in being able to be successful in that career</i> confidence	7	49	women	23.09 [#] (4.69)	24.87 (5.60)
			men	25.44 [#] (5.67)	26.63 [*] (5.69)
[*] Paired difference score significant, $p \leq .05$. [#] Gender difference significant, $p < .05$.					

⁶ In addition to gender, confidence in one's ability was significantly associated with race at the pre-test: non-white subjects were less confident in their abilities than were their white counterparts. This result is also consistent with the literature. At the post-test measurement, however, there was no statistical difference in confidence between races. While perceived race-based competency was not measured in this study, this preliminary result suggests the group project might have been a positive experience for non-white students. In particular, it is hypothesized that when non-white students had the opportunity to work with white students, they found that their own stereotypes were disproved; in particular, any preconceived concerns that non-white subjects had about the quality of their IT skills being below those of white counterparts may have been disproved when they found that their colleagues were no more skilled than themselves. This would parallel the results for women.

These six scores (one set at the pre-test and another at the post-test) were related to the subject's motivation for a career in IT and the subject's confidence in being able to be successful in that career. These results are shown in Tables 3 and 4.

Table 3: Impact of Group Attitudes on Post-test Motivation and Confidence Scores*

Scale	Group	Pre-test ATWIT Scores			Post-test ATWIT Scores		
		ATWIT-MIN ₀	ATWIT-MAX ₀	ATWIT-AVG ₀	ATWIT-MIN _T	ATWIT-MAX _T	ATWIT-AVG _T
<i>motivation for a career</i> motivation	women	n.s.	n.s.	F = 8.18	$p < .05$	F = 14.49	$p < .05$
	men	n.s.	n.s.	F = 9.27	n.s.	F = 12.90	$p < .05$
<i>confidence in being able to be</i> <i>successful in that career</i> confidence	women	n.s.	n.s.	F = 10.23	n.s.	F = 18.38	$p < .05$
	men	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
* The scores in each triplet (T-MIN, T-MAX, and T-AVG for the pre-test, and T-MIN, T-MAX, and T-AVG for the post-test) were compared to one another. In each case, the MIN, AVG, or MAX can be not significant (n.s.) or significant ($p < .05$). Where multiple scores (MIN, AVG, or MAX) are significant, the best predictor is indicated by listing the F score (which implies $p < .05$).							

Table 3 summarizes the effects of team-level ATWIT on subjects' final motivation (to study IT) score and on their final confidence (in their IT ability) score. As stated earlier, team measures at the beginning and end of the semester were correlated with students' final motivation and confidence scores. First consider the relationship of the pre-test ATWIT scores to the motivation of the subjects at the end of the semester (as shown on the left of Table 3). Neither the minimal ATWIT score nor the maximal ATWIT score were significantly associated with motivation. However, the average ATWIT score was positively associated with the motivation (to study IT) for both male and female students. So subjects who began (as measured at $T = 0$) the project with more typically positive team members (toward women in IT) were more motivated to pursue an IT career.

Next consider the final ATWIT scores (on the right side of Table 3) to the motivation of students to study IT at the end of the semester. Results showed that not only does the average team member's score, but also the team members with the lowest and highest ATWIT scores, impact the women's motivation (to study IT) by the end of the semester, but the ATWIT score of team member who is most positive toward women in IT is the one most highly correlated with women's motivation scores. A similar result was observed among the men. This suggests that the most supportive member of the group (as represented by the team member with the highest ATWIT score) was the one with the most influence on motivation (to study IT).

Similarly, Table 3 shows the relationship between team members' ATWIT scores (at the beginning and end of the semester) and confidence in one's ability to do IT. None of the scores had any power predicting the confidence of male students. The attitude of the typical team member was the only significant group measure to predict women's confidence in themselves. As with motivation, though, the most positive team member (as represented by the highest ATWIT score in a group) was the best predictor of both female and male subjects' confidence in the post-test. As with motivation, confidence seems to be influenced by the most positive people in the group.

Table 4 is similarly constructed. The dependent variable in Table 4, however, is the subjects' change in motivation (top) or confidence (bottom). As can be seen, the pre-test group ATWIT scores all had a significant relationship with the increase in motivation (to study IT) for both men and women (shown at the left of the table). The pre-test scores showed that the most supportive group member had the most influence on increasing motivation for both men and women. By the end of the semester (at the post-test), the most supportive (toward women in IT) team member's score was still the most influential for increased motivation (to study IT) for women, but the average group member was most influential in the increase in motivation (to study IT) for men. A similar pattern existed when examining the increase in confidence to study IT for men and women.

These results shed a different light on the question at hand. This analysis *does* support the idea that women are susceptible to the opinions of others and, thus, potentially susceptible to stereotype threat. However, *unlike* the literature, this suggests that although those negative to women pursuing careers in IT can discourage women, exposure to a champion can overcome those negative influences. That is, the most positive and supportive person in the group seems to affect women's motivation and confidence in their abilities *most*; the more supportive that person is, the greater the increase in women's motivation to study IT and their confidence in their abilities.

Table 4: Impact of Group Attitudes on Pre-test to Post-test Differences in Motivation and Confidence Scores*

Scale	Group	Pre-test ATWIT Scores			Post-test ATWIT Scores		
		ATWIT-MIN ₀	ATWIT-MAX ₀	ATWIT-AVG ₀	ATWIT-MIN _T	ATWIT-MAX _T	ATWIT-AVG _T
<i>motivation for a career</i> motivation	women	$p < .05$	F = 39.49	$p < .05$	$p < .05$	F = 38.09	$p < .05$
	men	$p < .05$	F = 80.39	$p < .05$	$p < .05$	$p < .05$	F = 52.46
<i>confidence in being able to be</i> <i>successful in that career</i> confidence	women	$p < .05$	F = 36.81	$p < .05$	$p < .05$	F = 31.53	$p < .05$
	men	$p < .05$	F = 91.76	$p < .05$	$p < .05$	$p < .05$	F = 54.92
* The scores in each triplet (T-MIN, T-MAX, and T-AVG for the pre-test, and T-MIN, T-MAX, and T-AVG for the post-test) were compared to one another. Scores can be not significant (n.s.) or significant ($p < .05$) in predicting a particular scale. Where multiple scores are significant, the best predictor is indicated by listing the F score (which implies $p < .05$).							

The fact that the positive ATWIT scores is also associated with an increase in male students' motivation to study IT and their confidence in their abilities is somewhat confusing, and was not at all predicted by the literature. Of course, it would be useful to probe this question in more depth. However, it is suspected that the measure is a surrogate for generally supportive individuals in the group. The more supportive the group is of everyone's ability to achieve success in the field, the more confidence everyone has in his or her work and the more motivated the individual is to pursue his or her work, but women, because of their predisposition in male-dominated fields to not feel accepted, respond best to the most supportive individual.

Cohesiveness of Project Groups

As stated earlier, group cohesiveness measures were adapted from women-in-science career studies used by earlier researchers and administered both at the beginning and end of the semesters. Table 5 shows the average composite score for cohesiveness at both the pre-test and the post-test of the entire sample (overall) and separated by gender.

As can be seen from Table 5, there was no discernible difference in the reported perceived group cohesion between men and women either at the beginning of the semester or at the end of the semester. While not shown in the table, there also were no discernible differences between men and women in any of the four subscales of cohesion. In addition, there is no discernible change in group cohesion scores from the beginning to the end of the semester. This similarity of scores provides greater evidence of the low stereotyping that was measured directly.

Surprisingly, the cohesion measures were not statistically related to the ATWIT scores either. The data were examined to consider the overall ATWIT score, as well as the three group-specific ATWIT scores, both at the beginning and the end of the semester, and their relationships with the cohesion scores, both at the beginning and the end of the semester. None of these tests were statistically significant. That suggests that stereotyping and stereotype threat played no role in establishing or breaking group cohesion among these subjects, and vice versa. Of course, the absence of a role is probably due to the unexpectedly high ATWIT scores of the male participants.

Finally, neither of the individual cohesiveness scales nor the composite scale showed a significant relationship with either a subject's motivation to study IT or his/her confidence in pursuing a career in IT. Hence it appears as though the group's connectedness (or the connectedness of the class) neither positively or negatively impacts career choices for these students. This provides preliminary evidence that a bad group experience may *not* alienate women (or men) from pursuing a career in IT, and that the teaching paradigm does not contribute to the declining percentages of women in IT.

Table 5: Cohesion Results

	Beginning of Semester Mean (sd)	End of Semester Mean (sd)	Within Group Change Over Semester
Women	58.88 (6.89)	60.04 (9.08)	n.s.
Men	61.71 (6.51)	60.15 (7.61)	n.s.
Between group difference	n.s.	n.s.	

V. DISCUSSION

The results of this study do not provide evidence that women in IS classes are harmed by the stereotype threat. Further, they provided no evidence that class-based cooperative learning exercises increase stereotype threat or negatively impact women's interest in, or commitment to, careers in IS.

These results, instead, seem to affirm Ogan, Robinson and Ahuja [2006] belief that the impact of stereotype threat for IT students found in the literature might be associated with the cultures in engineering departments and may not be generally found in programs outside of engineering that prepare students for IT careers, even though women represent a minority in those programs.

This study also suggests that negative group members do not seem to have a significant *net* impact on the motivation or confidence of women. Instead, it was the *positive* environment for women in IT, perhaps a champion for women in IT (as evidenced by a group member having a high ATWIT score), that showed the highest correlations with women's confidence in their ability and motivation to study IT. So, while there may continue to be those who exhibit negative stereotyping of women in IT, the bad effects might be overcome with positive influences. Further, the results suggest that a supportive environment for new professionals is important for *everyone* (*both males and females*) and the absence of a supportive environment can impact everyone, but that women are not disproportionately affected by this.

Of course, these issues, and others that help explain women's disaffection with computing require further study. This study does provide additional insight into the issues and further suggests that the issues might be of greater complexity than previously believed.

VI. LIMITATIONS AND IMPLICATIONS FOR RESEARCH

There are a number of limitations associated with this study. First is that the students chosen were all enrolled in the same Information Systems program at the same college of business. It is possible that the results are specific to that university. The tests need to be rerun at other universities to ensure generalizability. It is necessary to validate both the higher than expected attitudes toward women in IT among male students as well as the absence of impact of stereotype threat on women in the program.

Second, after the hierarchical regression analysis did not show the expected results, the analyses were effectively an exploratory analysis of the dynamics that might be inferred from the data that were available. This introduces some question of whether inferences about some measures, such as the relative supportiveness of team members, are appropriate. In this study, the team-ATWIT scores (average, maximum, and minimum) were used to reflect the atmosphere in a group and the relative supportiveness of team members. However, it is possible that one could have a very positive attitude toward women in IT, but not be supportive of individuals on your team, and have a very negative attitude toward women in IT, but still be supportive of the individuals on your team. Testing a verified measure of supportiveness would determine if the surrogate results are appropriate. The move from an experiment to an exploratory analysis also threatens the control of the significance level (the probability of a Type I error) and the power (the probability of a Type II error) of the analysis as a whole. Hence the results above were provided to recommend directions for future research.

However, given the extensive reliance on group work both in academia and in practice, it seems that the more important area for future research is in studying group dynamics and their impact on confidence and motivation. These preliminary results suggest that, in a group setting, it was the most positive person who had the biggest impact on confidence and motivation, especially for female students. Not only did the value of a "champion" have more significance in this study, it is a factor that is more easily manipulated both in class and in industry, and thus seems more worthy of future research.

Finally, the results do not provide evidence of *why* differences seem to exist in the acceptance of women in computer science and information systems departments. It is possible that there is a self-selection bias in the male and/or female students in non-engineering-based IT programs. For example, perhaps the students in business schools have, on average, more refined social skills or have had exposure to more heterogeneous populations than those who opt for engineering schools. Those explanations, of course, need empirical testing. Another explanation for the results might be the curricular and pedagogical philosophies in the different kinds of programs. A number of researchers have identified that women excel in computer technology when they can see the *reason* for using the technology, not just to see the various things a computer can do [Bernstein, 1997; Cole, Conlon, Jackson and Welch, 1994; Druin, 2001; Fischer, 1997; Frenkel, 1990; Gefen and Straub, 1997]. Similarly, Fischer [1997], Bernstein [1997] and Cole et al. [1994] have all noted that many female students learn computing best in a "purposeful context" (how it might be applied to solve some real problem). In addition, von Hellens, Nielsen, Doyle

and Greenhill [1999] and Neilsen, von Hellens, and Wong (1999), found that female students who did not see the link between what they were doing in the classroom and how it gets applied in industry were less likely to continue with computer-oriented careers. Such a “purposeful context” often is more obvious in IS curricula than in computer science curricula. For example, computer science curricula generally focus on the efficiency of the computer performance. As such, the courses emphasize algorithms and detailed level computer concepts, the value of which may not be obvious to a student until he or she is far along in an academic program. MIS programs, on the other hand, generally focus on making the computer help the organization perform to its highest potential. As such, the courses emphasize the computer’s applications to business and end users, which are more obvious earlier in the student’s academic program. Students in the MIS programs, then, are more likely to understand *why* they are learning things; according to the literature, such a curriculum would appeal more to women (on average) than would the algorithmic approach of computer science programs. Hence, the level of “purposeful context” may be a mitigating factor in understanding the role factors such as the Theory of Stereotype Threat might play in explaining low female enrollments in IT programs. Joshi and Schmidt [2006] suggest that this applications orientation helps students develop a broader view of the field and thus the desirability of being in the field. This, of course, needs further study.

VII. IMPLICATIONS FOR PRACTICE

The news for practice is that this research, even at its preliminary level, dovetails nicely with recent research on the value of mentoring for women in IT. For example, MentorNet, a worldwide, online mentoring community to encourage underrepresented groups in science and engineering has had a positive impact on retention of women in IT. A recent survey found that over 90 percent of the mentored STEM students (68 percent of whom were women) completed their degrees. Each of these students had access to a supportive and enthusiastic mentor in the field. The protégés report increased confidence in their abilities and an increased motivation to succeed in their chosen fields. Other researchers have also shown that good mentoring relationships can enhance self-esteem and lead to increased confidence in abilities and motivation to succeed [Packard and Nguyen, 2003; Underhill, 2006]. Turner, Bernt, and Pecora [2002] note that women who do choose IT programs are more likely to have received greater encouragement than discouragement to do so, even if it is not specifically from a mentor.

This suggests IS programs should consider adopting mentoring programs that match college students with supportive mentors to help increase retention and graduation rates for women in IS. These mentors might be upperclass students (for freshmen and sophomores) or alumni and other women affiliated with a university. They need to be trained not only to provide advice about curricula, career management, and job selection, but also to provide confidence-building support. This research suggests the mentors need to be knowledgeable and enthusiastic, but can be either men or women, thereby increasing the pool from which to select mentors. Not only could this improve retention of current students, but it also could be publicized to attract new students.

This research, however, leaves open the question of why women are not enrolling in greater numbers in IS programs in colleges of business (or other non-engineering IT programs). One explanation may be the general absence of awareness among high school girls (and their parents) that this option is available. Thus increasing awareness, especially with regard to the differences between an IS program and a computer science program, might be a simple solution to the question of increasing women in the field.

The key components, according to Koch, Van Slyke, Watson, Wells, and Wilson [2010], of attracting more students to IS include events, early intervention, awareness campaigns, and changes to the program. Events for undergraduate students have proven effective in attracting more students in general to the IS program. Koch et al. [2010] suggest events that highlight opportunities, changes in technology, or a current trend that has national press. Similarly, early intervention efforts are aimed at providing more information to the pre-collegiate student. Some examples involve providing materials and fun giveaways at collegiate fairs and providing IS programs at high schools. Awareness programs include poster advertisements on high school buses, and collegiate bulletin boards. They might also include articles in newspapers highlighting opportunities and the shortage of IS majors in today’s market, and a greater presence at college fairs. Recommended curriculum changes included more flexibility in the program, more electives, and partnering with other departments for joint classes.

These recommendations all apply to attracting women to IS as well. Organizers need to be attentive to including women in the outreach. When staffing tables at fairs, creating posters and online ads for majors, and other intervention activities, women should be targeted for special attention. Women practitioners should be included in the pool of speakers, and organizers need to ensure they are at the same level in the organization as the men practitioners in the pool. Many girls need to see other people like them before they will consider a career path. These women need to be not only present, but clearly equal players in the field and not just stand-ins for effect. An effort at outreach to single-gender schools is warranted as well.

In addition to providing role models at events, organizers need to be attentive to the topics that are highlighted in materials. Research shows that many young women are driven by a desire to help others. So, while materials highlighting applications and jobs using IS in accounting or finance might not motivate them, highlighting applications in health care or not-for-profit organizations might hold their attention more significantly.

With subtle changes in how departments recruit students, we could bring more women into the field and thus increase the diversity of the teams that develop systems. This, in turn, is likely to improve the quality of the systems, which will benefit us all.

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APPENDIX A: ATTITUDE SURVEY

Please take a few minutes to complete the survey below describing your attitudes about men and women in the information technology field (a term that we will use to include the subfields of Information Systems and Computer Science). The survey will not affect your performance in class in any way. Your response will be kept confidential. This is a pre-test for a cross-disciplinary research project. For each of the six statements below, mark on the 7-point scale the extent to which you agree or disagree with each statement. Please rate all six statements.

	Disagree Strongly			Neither Agree Nor Disagree			Agree Strongly	
Women have the innate ability to be as good in information technology as men.	1	2	3	4	5	6	7	
Men are more qualified to become information technology professionals.	1	2	3	4	5	6	7	
Women can make important <i>original</i> contributions to information technology.	1	2	3	4	5	6	7	
Only men can achieve at the highest level in information technology.	1	2	3	4	5	6	7	
We need more women in information technology careers.	1	2	3	4	5	6	7	
Information technology work can be done as well by women as by men.	1	2	3	4	5	6	7	

Describe yourself:

I am a(n):

☐ graduate student

Specify Program:

☐ MBA ☐ MAcc ☐ MS MIS ☐ MS CSc
☐ Other _____

(please specify)

- ☐ undergraduate student
- ☐ BSBA
- ☐ BSA
- ☐ BS MIS
- ☐ BS CSc
- ☐ Other _____
(please specify)
- ☐ community college student

My age group is:

- ☐ < 21
- ☐ 21–25
- ☐ 26–30
- ☐ 31–40
- ☐ 41–50
- ☐ 51–60
- ☐ > 60

My gender is: ☐ male ☐ female ☐ I am a Foreign National

My ethnicity is:
☐ White, nonhispanic ☐ African ☐ Asian ☐ East Asian Indian ☐ Native American
☐ Hispanic ☐ Middle Eastern ☐ other _____
(please specify)

My employment history:
☐ includes one or more full-time positions ☐ does not include any full-time positions

APPENDIX B: IT CAREER SURVEY

In each of the questions below, we use the term *IT* to reflect the career paths generally associated with Information Systems, Information Technology and Computer Science.

Student ID Number: _____
Class: _____

In the five IT items below, please rate your commitment and motivation for an IT career.

	Disagree Strongly				Neutral			Agree Strongly
I would (do) enjoy a career in IT.	1	2	3		4	5	6	7
Having a career in IT would be (is) interesting to me.	1	2	3		4	5	6	7
I sometimes think about dropping out of IT.	1	2	3		4	5	6	7
I am not sure that IT is really the career for me.	1	2	3		4	5	6	7
I have decided I would like to have a career in IT.	1	2	3		4	5	6	7

In the six items below, please rate your confidence in your IT abilities.

	Disagree Strongly				Neutral			Agree Strongly
I have a lot of confidence in my abilities in IT.	1	2	3		4	5	6	7
Classes in IT are hard for me.	1	2	3		4	5	6	7
I can do well in IT even if I have a poor teacher.	1	2	3		4	5	6	7
Sometimes it takes me a long time to do my assignments in IT.	1	2	3		4	5	6	7
IT comes easily to me.	1	2	3		4	5	6	7
For me, IT classes are fun.	1	2	3		4	5	6	7

We all think about the future and what kind of experiences are in store for us. Some of these experiences you may be quite sure will happen and some you may be more unsure of. Let us say you decide you would like to have a career in IT. Think about what is likely or possible to happen to you in the future if you decide you want this type of career. For each of the experiences listed below, rate how confident you are that each would actually happen to you.

	Not at all confident				Neutral			Very confident
I will graduate with a college degree in IT.	1	2	3		4	5	6	7
I will get a job in IT.	1	2	3		4	5	6	7
I will stay in IT and do acceptable work in my job.	1	2	3		4	5	6	7

I will have a strong professional career and make substantial contributions.	1	2	3	4	5	6	7
I will become tops in my field—one of the best in the country.	1	2	3	4	5	6	7
<p><i>Now let us say you do enter the field of IT. What is likely to happen to you in the future after you have a career in this field? Use the following scale to rate how likely each of the following would be.</i></p>							
	Not at all likely			As Likely as Not			Very likely
I will not have as much contact with other people as I would like to have.	1	2	3	4	5	6	7
When I introduce myself to people, they will admire me for being in IT.	1	2	3	4	5	6	7
I will have enough time to enjoy personal relationships with people I care about.	1	2	3	4	5	6	7
The people close to me will never fully accept that I have a career in IT.	1	2	3	4	5	6	7
My career will interfere with keeping up important personal relationships.	1	2	3	4	5	6	7
I will be able to balance my roles at home and work—keeping up with my career and a full personal life, including a family (if I want one).	1	2	3	4	5	6	7
The people close to me will support me in my work.	1	2	3	4	5	6	7
It will be difficult to keep up with my career and still have time for a full and enjoyable personal life, including have a family (if I want one).	1	2	3	4	5	6	7

APPENDIX C: GROUP RATING FORM

Take a few moments to reflect on your group, its performance, and your interactions within the group. Then rate each of the following dimensions regarding your group experience in the last week. These materials will be kept confidential, but will be used to facilitate group dynamics. Turn it in as instructed.

Name:

Student ID Number:

Group:

Class:

Date:

Please comment on each of the following regarding your team meetings by selecting the appropriate number.

1. To what extent are you satisfied with group meetings?
2. To what extent did you contribute to the meetings?
3. To what extent were your ideas accepted and used by the group?
4. To what extent did one or two group members dominate the discussions?
5. If your answer to question 4 was yes, to what extent did you personally resent over-participation by other members?

Not at all			Somewhat		A Great Deal
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	

Below is a list of statements. Please indicate the extent to which you agree or disagree with each.

6. In general I respect the other students in this group.
7. On the whole, I trust the other students to do their part to make the project a success.
8. For the most part, I feel that other students in this group are willing to try to help me when I ask.
9. I do not think the other students appreciate having me in this group.
10. I feel that the students in this group do not respect me.
11. I do not think the other students are helping to take this project in a worthwhile direction.
12. I feel it is useful to do the assignments with other students in this group.
13. When other students in this group make suggestions, I find their suggestions helpful.
14. I find it frustrating to do the assignments with other students in this group.
15. In general, I think the other students waste time in this group.
16. In general, the other students and I disagree about how to approach this group project.

Disagree Strongly			Neither Agree or Disagree		Agree Strongly
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	

17. Write a short paragraph about what you think about the processes of this group.

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Vicki Sauter is Professor of Information Systems at University of Missouri–St. Louis. Her research centers on Decision Support Systems and Business Intelligence, focusing on the informational choices of decision makers, and their impact on the design of BI tools. In particular, she examines the models and model management features that would facilitate information use and has examined these issues in both the public and private sectors, and in cross-cultural domains. Her book, *Decision Support Systems for Business Intelligence*, has recently been published in its second edition, and her articles have appeared in numerous journals. Her recent interest in increasing the number of women who pursue the IT profession was motivated by the declining number of women in the field. Professor Sauter holds a doctorate from Northwestern University.

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