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In this issue:

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Julia Colyar
University Buffalo State University New York
Buffalo, NY 14260-1000 USA

Belle S. Woodward
Southern Illinois University
Carbondale, IL 62901 USA

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Women Students' Confidence in Information Technology Content Areas

Julia Colyar
jecolyar@buffalo.edu
Department of Educational Leadership and Policy
University at Buffalo, The State University of New York
Buffalo, NY 14260-1000, USA

Belle Woodward
bellew@siu.edu
Department of Information Systems and Applied Technology
Southern Illinois University
Carbondale, Illinois 62901, USA

Abstract

This paper reports on a survey administered to 105 students in information technology majors at a large, public Midwestern university. The survey was designed to address students' levels of self-confidence in IT-related content areas. In addition, the survey was intended to explore gender differences in IT student support needs. The study found that male and female students reported similar levels of confidence in mathematics. However, male students reported higher levels of self-confidence than female students in all IT-specific content areas. A regression analysis showed a correlation between gender and confidence in programming, networks, and cryptography. No differences were found in student support needs based on gender. This exploratory research supports some previous studies in this area, but provides additional information regarding the specific content areas in which women students need support. Unlike previous research, this survey showed no difference in math confidence based on gender. However, these findings indicate that women students may require additional support in other areas. This research is limited in terms of its generalizability; instead, it suggests areas for further research.

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1. INTRODUCTION

For many years, educational researchers have documented the enrollment and graduation rates of women undergraduate students in Science, Technology, Engineering and Mathematics (STEM) programs (National Science Foundation, 1996; Astin & Astin, 1993; Strenta, Elliot, Adair, Matier, & Scott, 1994; Ramirez, Laurel, & Rodriguez-Aguilar, 2000; Didion, 1997; Margolis & Fisher, 2002). Despite outnumbering male undergraduate students in overall postsecondary enrollment, women students are still underrepresented in STEM programs (Chronicle of Higher Education Almanac, 2005-2006; Zewotir, 2000). Recent research has looked at various aspects of female student experience in order to understand this enrollment and achievement gap, including institutional environment, disparity in financial aid awards, campus support services and mentoring programs, perceptions of IT as a career, and individual students' background characteristics and preparation. In particular, research addressing self-confidence in math and science has provided an important focal point for understanding women students' attrition rates in Information Technology majors.

This paper expands the available research on women students' levels of self-confidence and looks specifically at students' perceptions of their abilities in IT related content areas. In addition, this study explores the academic support services students seek as a means of enhancing their academic success. The findings suggest that women students' experiences can be understood more completely by exploring the specific content areas in which they need support.

2. LITERATURE REVIEW

Researchers have noted that female students perceive themselves to struggle more than their male peers (Barker & Garvin-Doxas, 2004; Margolis & Fisher, 2002). Regardless of outside-of-class experiences or ability level, women students assume that male students know more and struggle less (Margolis & Fisher, 2002). Male students are assumed by some female students to "dream in code"—that is, to "do nothing but computer science" (Margolis & Fisher, 2002, p. 69).

As evidenced in the literature, questions of women students' self-confidence are influenced by many aspects of computing experiences. For example, women students are often outnumbered in undergraduate IT classrooms, reinforcing the stereotype that IT is a "masculine" field and making women students feel "lost, unsupported, and unconnected" (Margolis & Fisher, 2002, p. 83). Thomas and Allen (2006) also report that women students perceive IT professionals as stereotypically "nerds" or "uncool" (p. 175). In addition, Thomas and Allen note that women students do not report having female IT role models, which again supports the perception that the field is dominated by men.

Classroom experiences also influence women's self confidence. While female IT students are drawn to cooperative learning opportunities and cross-disciplinary perspectives, IT classrooms are typically competitive in nature and focused on technical programming (Hughes, 2002; Margolis & Fisher, 2002; Smithson, 1990). In addition, the quality of instruction, Margolis and Fisher note, is more important to female than male students. Large classes and "unhelpful" faculty can have severe negative effects on women students, causing them to rethink their intended major and career. Thus, the curriculum as well as classroom interactions are often discouraging to female students, undermining their levels of self-confidence.

Researchers have also noted that faculty call on male students more often and praise male students more often than female (Huang & Brainard, 2001). Huang and Brainard (2001) noted that compared to male students, female students are more likely to be interrupted by faculty, and less likely to be called on by first name. Individual events such as these, combined with assumptions women students have about the IT field and the talents of their male peers, have an important influence on women students' self-confidence and their decisions to stay in IT programs.

Women's self confidence in STEM programs has been examined using various research methodologies. Margolis and Fisher (2002) completed extensive surveys and interviews with women students at Carnegie Mellon University. Huang and Brainard (2001) examined the gender gap in levels of academic self-confidence using the Engineering Student Experience survey. This study focused on self-confidence in math and science as a means of understanding the "processes by which women lose confidence in their abilities in the science, math, engineering, and technology (SMET) fields" (p. 316).

Despite the important scholarship completed in this area, women student experiences and their self-confidence in pursuing an undergraduate major in Information Technology still requires additional research. In particular, assessing women students' levels of self-confidence could use a more focused approach. In this study, we draw on previous research but also seek to better understand questions of women students' self-confidence; this study is particularly interested in the content areas addressed in information technology courses and the support services students seek as a means of enhancing their academic success.

Research questions for this exploratory study included:

1. Do women students report lower levels self-confidence in Information Technology content areas than male students?

2. Do men and women students seek different supplemental academic support as a means of enhancing their professional preparation in IT?

3. RESEARCH METHOD

The method used for exploring these questions was a survey. The survey was developed by the authors, based on a review of surveys prepared for similar studies, and tailored to the local population. This survey consisted of mostly quantitative questions, with some qualitative responses. Survey questions included demographic information, educational background information, work experience related to IT, and questions related to peer and family support for the student's intended major. Using a 5-point Likert-type scale, the survey also asked students to rate their confidence levels in math and ten IT-specific content areas including programming, networking, security, cryptography, software and hardware. In addition, the survey asked students to identify information technology content areas they would like more practice with or exposure to. The reliability of the scores that resulted from the administration of this instrument was assessed by calculating Cronbach's alpha. The value (0.863) indicated a high level of reliability.

The survey was administered to 150 Information Systems and Applied Technologies (ISAT) students. The students were selected because of their enrollment in Information Technology courses. The majority of students (71%) were Information Systems Technology (IST) majors; 22% were Electronics Systems Technology (EST) majors, 1% were Computer Science (CS) majors, and 6% were other majors. Students were enrolled as sophomores, juniors, or seniors. The sample was one of convenience; at the beginning of the fall semester 2006, the researchers identified faculty members of several classes in the School of Information Systems at a large, public Midwestern university who were willing to provide class time for the administration of the survey. In each classroom, the purpose and procedures of the research study were explained to the students by one of the researchers. Then the students were given approximately 20 minutes to complete the survey in class. Some faculty members offered extra-credit points for completing the surveys, and others used it as a regular class activity with no points assigned.

Research Results

The survey was administered to 150 students; 105 students responded, giving a participation rate of 84%. An analysis of the descriptive statistics of the students' characteristics indicated that the average age of participants was 23.97 (standard deviation = 5.93). Eighty-six percent of the students were male, and 14 percent were female (See table 1, Appendix A). Eighty percent of respondents were white. This gender distribution mirrors the distribution of the overall population of students in the College of Applied Arts and Sciences.

Demographic data also showed that 81% of students completed computer courses in high school, with the median age of first use being 12. Male students were more likely to report computer coursework in high school, and began using computers at an earlier age.

4. STUDENTS' LEVELS OF SELF-CONFIDENCE

Using a Likert scale, respondents were asked to rate their level of confidence in math and IT-specific skills. Table 2 (see Appendix A) shows the content areas students responded to and the median scores for each by gender.

As Table 2 indicates, women students reported lower median confidence scores on a 1-5 Likert scale in all content areas. Women students reported confidence levels ranging from 1.7 to 3.7. Male students reported levels of confidence ranging from 2.1 to 4.0.

A correlation matrix was constructed in order to determine if any significant relationships existed among the variables. Table 3 (see Appendix A) summarizes the matrix, and indicates a positive correlation between Gender and Confidence in Programming, Confidence in Networks, and Confidence in Cryptography. Ethnicity and Confidence in Math also showed a positive correlation. The students' Major, Confidence in Networks, and Confidence in Math is also positively correlated.

As seen in Table 3, there were high and very high correlations among the variables (Gender, Ethnicity, Confidence in Program-

ming, Confidence in Math, Confidence in Network, Confidence in Cryptography, and Major). Based on these results, several multiple regression analyses were executed. These are reported below.

A multiple regression analysis was run using Major, Ethnicity and Gender as independent variables and Confidence in Math as the dependent variable. The multiple regression analysis (Table 4, Appendix A) showed a significant relationship between Ethnicity and Confidence in Math ($F = 6.639$, p value = 0.000).

Of the three predictors, Ethnicity was significant ($t = 3.276$, p value = .002). These results indicate that non-white students were more likely to express lower confidence in their math skills. There was no significant relationship between gender and math confidence, which indicates that women students and male students report similar levels of confidence in this area.

Another multiple regression analysis was run using Major, Ethnicity and Gender as independent variables and Confidence in Programming as the dependent variable. The multiple regression analysis (Table 5, see Appendix A) showed a significant relationship between Gender, Ethnicity and Confidence in Programming ($F = 5.148$, p value = 0.003).

Of the three predictors, Gender was significant ($t = 3.454$, p value = .001). Women students were more likely than male students to express lower self-confidence in programming.

Additional regression analyses were run (Tables 6 and 7, see Appendix A) using Confidence in Cryptography (Table 6) and Confidence in Networking (Table 7) as dependent variables and Ethnicity, Sex, and GPA as independent variables. As indicated in Table 6, both Ethnicity and Gender are related to the students' Confidence in Cryptography. However, GPA was not an indicator of a student's Confidence in Cryptography.

As in the previous regression analysis, GPA plays no factor in a student's level of confidence. However, whereas Confidence in Cryptography was influenced by Ethnicity, Confidence in Networking was not related to Ethnicity. Confidence in both Networking and Cryptography are related to gender.

5. STUDENTS' SUPPORT NEEDS

The final questions on the survey asked students to indicate additional skills or content knowledge they wished would be covered in their coursework; students chose from a list of fifteen specific areas. Students were also asked to indicate any support services they would like to have access to. This question required students to fill-in an answer rather than choose from a pre-existing list.

A correlation matrix was constructed to determine if there was a significance relationship between wished-for content knowledge areas and gender. The correlation matrix indicated no significance. Qualitative responses to the final survey question "What support services do you wish your program/major offered?" were analyzed according to content. Responses were categorized by type. Only 22.9% of students provided a response. Many of these write-in responses dealt with general student needs rather than specific IT-related interests. For example, three students indicated they would like better parking options and financial aid. Five students indicated they would like tutoring, which is a service already offered by the IST department. These results suggest that students, both male and female, are unaware of what services might benefit them. They are unsure of what to ask for in terms of services and support.

6. DISCUSSION

Several important results are evident in these findings. Though previous research indicates that women students report lower levels of confidence in math, these findings do not show a difference in math confidence based on gender. Instead, these findings indicate that non-white students report lower confidence in mathematics. As student populations become more diverse in terms of race and ethnicity, these findings will become increasingly important to follow.

These findings also indicate that survey questions related to math confidence may not provide enough information regarding women students' experiences and their specific confidence-levels related to IT content areas. While IT students are required to use their math skills in many IT courses, they may not consciously be drawing on their mathematics skills; that is, their math skills are

part of the foundational work that is not typically directly addressed in their courses. Students may not even be aware that they are drawing on their math skills in order to solve complex IT problems. However, students are asked to directly apply networking, cryptography, and programming skills; these areas are overtly part of course content. Asking students to indicate their level of confidence in these areas may provide more direct access to their day-to-day course confidence.

The findings reported above indicate that gender is related to confidence in programming, networking, and cryptography. Women students reported less confidence in these areas than male students. In each case, however, the students' grade point average was not a significant factor, which indicates that the students' performance level (as evidenced in their grades) may not be related to their confidence in the subject. This finding echoes previous research which found that women students are often discouraged in their IT courses despite performing well academically.

Finally, findings related to wished-for content knowledge or support services indicate that male and female students do not differ in terms of perceived needs. Interpreted one way, these results may indicate that both male and female students are uncertain what their strengths and weaknesses are, and so are unable to identify areas where they may need additional assistance or course coverage. Additional research in this area is needed to better understand how these concerns may be important in understanding student experiences and challenges.

7. CONCLUSION

These findings provide insights regarding women students in IT courses not already specified in the literature. In particular, these findings suggest that further research should be conducted using surveys with more specific content-based questions related to IT student confidence. The findings indicated here can provide researchers and IT faculty important information for encouraging and assisting women students in particular content areas, with the ultimate goal of retaining more women students in the discipline.

These findings also suggest additional areas for exploration. For example, male student confidence in the specific IT areas should be further studied. Future surveys should look at students' academic preparation and experience in networking, programming and cryptography, as well as other specific areas. Their experience and preparation may help explain the differences in levels of confidence. Perhaps male student confidence in networking, programming and cryptography is related to previous coursework or experience they received prior to their enrollment in college. Additional, related questions also remain: Do women feel less confident in these areas because they are surrounded by men and taught by men? Are women more realistic about their level of preparation? Providing answers to these questions will assist researchers and faculty in enhancing women student experiences and providing environments that will encourage and support their success.

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APPENDIX A

Table 1: Student Respondents' (Gender and Major)

	Gender		Total	
	Male N (%)	Female N (%)	N	(%)
IST	64 85%	11 15%	75	71%
EST	20 87%	3 13%	23	22%
CS	1	0	1	1%
OTHER	5	1	6	6%

Table 2: Confidence Levels by Gender and Content Area

SEX	Content Area	N	Minimum	Maximum	Mean	Std. Deviation
FEMALE	Programming	15	1.00	3.00	1.7333	.88372
	Mathematics	15	1.00	5.00	2.6667	1.23443
	Networks	15	1.00	4.00	2.3333	1.11270
	Security	15	1.00	5.00	2.8667	1.18723
	Network Security	15	1.00	4.00	2.5333	1.18723
	Cryptography	15	1.00	3.00	1.5333	.63994
	Software	15	1.00	5.00	3.7333	1.16292
	Hardware	15	2.00	5.00	3.6667	1.17514
	Database	15	1.00	5.00	2.6667	1.34519
	Troubleshooting	15	1.00	5.00	3.4667	1.18723
	Valid N (listwise)	15				
MALE	Programming	90	1.00	5.00	2.8444	1.12091
	Mathematics	90	1.00	5.00	3.1667	1.19220
	Networks	90	1.00	5.00	3.4000	1.16888
	Security	90	1.00	5.00	2.9778	1.19904
	Network Security	88	1.00	5.00	2.8295	1.27055
	Cryptography	88	1.00	5.00	2.1818	1.10947
	Software	90	1.00	5.00	3.8333	1.08359
	Hardware	90	1.00	5.00	4.0667	1.03642
	Database	90	1.00	5.00	2.7778	.96893
	Troubleshooting	90	1.00	5.00	3.9333	1.11979
	Valid N (listwise)	86				

Table 3: Correlation of Gender, Ethnicity, Major and Confidence in IT tasks

Correlations

		SEX	CONFI_PROG	CONF_NETWORKS	CONF_CRYPT	CONF_MATH	B_W_Ethnicity	IST_EST
SEX	Pearson Correlat	1	.338**	.309**	.214*	.146	.157	.027
	Sig. (2-tailed)		.000	.001	.030	.138	.121	.793
	N	105	105	105	103	105	99	99
CONFI_PROG	Pearson Correlat	.338**	1	.282**	.367**	.160	-.182	-.165
	Sig. (2-tailed)	.000		.004	.000	.103	.071	.104
	N	105	105	105	103	105	99	99
CONF_NETWOI	Pearson Correlat	.309**	.282**	1	.391**	.003	-.024	-.269**
	Sig. (2-tailed)	.001	.004		.000	.972	.816	.007
	N	105	105	105	103	105	99	99
CONF_CRYPT	Pearson Correlat	.214*	.367**	.391**	1	.009	-.173	-.135
	Sig. (2-tailed)	.030	.000	.000		.931	.088	.189
	N	103	103	103	103	103	98	97
CONF_MATH	Pearson Correlat	.146	.160	.003	.009	1	.269**	.201*
	Sig. (2-tailed)	.138	.103	.972	.931		.007	.046
	N	105	105	105	103	105	99	99
B_W_Ethnicity	Pearson Correlat	.157	-.182	-.024	-.173	.269**	1	.281**
	Sig. (2-tailed)	.121	.071	.816	.088	.007		.006
	N	99	99	99	98	99	99	93
IST_EST	Pearson Correlat	.027	-.165	-.269**	-.135	.201*	.281**	1
	Sig. (2-tailed)	.793	.104	.007	.189	.046	.006	
	N	99	99	99	97	99	93	99

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

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

Table 4: Regression Analysis of Confidence in Math with Gender, Ethnicity and Major

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23.493	3	7.831	6.639	.000[a]
	Residual	104.980	89	1.180		
	Total	128.473	92			

a. Predictors: (Constant), SEX, IST_EST, B_W_Ethnicity

b. Dependent Variable: CONF_MATH

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.738	.361		4.813	.000
	IST_EST	.303	.272	.111	1.113	.269
	B_W_Ethnicity	.977	.298	.329	3.276	.002
	SEX	.551	.328	.163	1.682	.096

a. Dependent Variable: CONF_MATH

Table 5: Regression Analysis of Confidence in Programming with Gender, Ethnicity and Major

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16.831	3	5.610	5.148	.003[a]
	Residual	96.997	89	1.090		
	Total	113.828	92			

a. Predictors: (Constant), B_W_Ethnicity, SEX, IST_EST

b. Dependent Variable: CONFI_PROG

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.154	.347		6.206	.000
	SEX	1.087	.315	.341	3.454	.001
	IST_EST	-.257	.262	-.100	-.980	.330
	B_W_Ethnicity	-.499	.287	-.178	-1.740	.085

a. Dependent Variable: CONFI_PROG

Table 6: Regression Analysis of Confidence in Cryptography with Gender, Ethnicity and GPA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.565	.543		2.882	.005
	SEX	.907	.375	.270	2.419	.018
	GPA	.113	.154	.080	.737	.463
	B_W_Ethnicity	-.725	.299	-.268	-2.423	.018

a. Dependent Variable: CONF_CRYPT

Table 7: Regression analysis of Confidence in Networking with Gender, Ethnicity and GPA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.052	.616		4.955	.000
	SEX	.912	.425	.247	2.145	.035
	GPA	-.099	.174	-.063	-.570	.570
	B_W_Ethnicity	-.382	.340	-.128	-1.125	.264

a. Dependent Variable: CONF_NETWORKS