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Why don't more women major in information systems?

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Abstract

Purpose – Increasing enrollments in colleges of business have not been matched by women majoring in the field of information systems (IS). This paper aims to explore reasons why women choose not to major in information technology disciplines and to suggest potential solutions.

Design/methodology/approach – The authors used a behavioral model based on the theory of reasoned action and a survey of the students enrolled in six sections of a college-wide MIS course to help them answer the fundamental question "Why don't more women major in information systems?" They also used partial least squares analysis to estimate the parameters of the model and the results of several open-ended survey questions to validate their statistical findings, leading to a richer triangulation of study results.

Findings – The study found that a "genuine interest in IS" and the "influence of family" most account for a woman's decision to major in information systems. Equally important are those items that did not appear to attract females, including such matters as "job-related factors" or the "influence of fellow students or friends". These findings have important recruitment and retention implications as well as suggesting some avenues for further study.

Originality/value – The analyses suggest that there is much faculty and business recruiters can do to encourage more females to major in IT-related disciplines. One is to encourage women to develop more interest in the field. Another is to create more study options for women with hard-science talents who want to pursue technologically-intensive careers. Finally, teachers, academic institutions, and employers might find it useful to address some of the misconceptions that women might have about IT-related jobs – for example, that IT jobs are only for males or computer geeks – and stress the many positive dimensions of IT career paths.

Keywords Gender, Information studies, Information technology Equal opportunities

Paper type Research paper

1. Introduction

Despite two decades of state and federal legislation, women still face difficulties in achieving equal representation and opportunities in information and technology-related industries in general, and such hard sciences as "information systems" in particular (Richardson, 2009). In 1995, for example, women held only 20 percent of the information-technology (IT) jobs in the USA – a statistic echoed in a more recent national survey of 11,000 recent college graduates, which found that women occupied 21.3 percent of jobs in the hard sciences (including computer science) (Morgan, 2008).

There are several reasons why managers might want to attract more females to industry. In the past, for example, a scarcity of technically-qualified employees has required businesses to pay unexpectedly high salaries or signing bonuses to attract top-flight personnel or to replace retiring baby boomers (Murphy, 2005). Recently, industry leaders from the Business Roundtable expressed concern that the industrial nations have the potential to lose their competitive edge as technically-competent

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students graduate from offshore institutions and begin work in competitor businesses abroad (Wadhwa, 2008). Increasing the number of women majoring in the IT related fields would mean that domestic organizations can draw from a larger pool of qualified employees to help them address these problems.

Another reason for hiring women in technology-related disciplines is to help IT departments escape the image of male-dominated clubs (Lomas, 2008a; Reddock *et al.*, 2008). Loraine Rodgers, onetime CIO of Xerox Corporation, for example, reports that in 1965, she was told that "only men were programmers. . .even if [women] had a college degree" (Anthes, 2008). Even a cursory reading of the available literature suggests that hers was not an isolated experience (Benyo *et al.*, 2009; Beyer *et al.*, 2004; Turner *et al.*, 2002; Trauth, 2002), although Ceci and Williams (2009) found evidence suggesting gender discrimination was either dated or anecdotal.

Nonetheless, gender inequalities continue to be a world-wide concern to those in the information technology field today (Hafkin, 2004; Lomas, 2008b). This is unfortunate because a 2008 report by the US Department of Labor, predicts a 30 percent increase in demand for computer technology related jobs such as computer analyst, database administrators and software engineers between 2008 and 2016 (Bureau of Labor Statistics, 2010). If employers hope to meet this demand, they cannot limit themselves to male applicants, but instead must carefully recruit, engage, promote, and retain women in the technology fields (Fountain, 2000; Ahuja, 2002).

One way that academics can help remedy gender imbalances in the science, technology, engineering and mathematics (STEM) disciplines is by attracting and retaining more females to their majors (Kastrul, 2008). However, the statistics suggest that this is likely to be a difficult task. For example, in 2005 the National Science Foundation examined students earning degrees in information-technology-related disciplines, but found that only 25 percent of these degrees went to women (Chute, 2009). In another example, the Program for Women in Science and Engineering at Iowa State University found that women accounted for only 40 percent of all students enrolled in STEM programs (W.S.E., 2008). Similarly, women earned only 28 percent of the degrees in computer or information sciences according to the US Department of Education (Turner *et al.*, 2002). Finally, a 2004 study by the Higher Education Research Institute found that only 0.3 percent of incoming freshmen college women expressed an interest in majoring in computer or information sciences (Foster, 2005).

The authors were interested in why women choose not to major in IT disciplines. Given that "information technology" covers a broad group of related disciplines, they focused on the field of "information systems" (Agarwal and Prasad, 1998). O'Brien and Marakas (2005) define information systems as the discipline focused on the people, hardware, software and communication technologies used in business to accomplish work. We use this definition to clarify our perspective throughout this manuscript.

The next section of the paper provides some background and reviews the literature to identify potential reasons for the relatively low number of women majoring in information systems. Section three describes a two-part survey conducted by the authors to verify past studies and to identify additional reasons for low numbers of women in IS. The fourth section of the paper describes our findings, the fifth section provides further evidence drawn from our initial survey, and the final section provides a summary and conclusions.

2. Background

More is known about the existence of gender imbalances than is understood about their causes (Trauth *et al.*, 2008). Why do not more women major in information systems? This section examines some of the factors that affect the number of women who pursue information system majors and related careers.

2.1 It is not about capabilities

Several authors have examined factors that can influence a woman's decision to pursue a career in the information technology workplace (Ahuja, 2002; Grant and Knight, 2007; Grant *et al.*, 2007; Trauth *et al.*, 2008). Adya (2005) found that early accesss to computers reduced intimidation, arguably increasing perceptions of individual capabilities. Recent studies suggest that "interest levels", rather than "ability levels", are the more important determinants in the choice of a university major (Benyo *et al.*, 2009; Ceci and Williams, 2009). For example, a study of 1,000 high school students conducted at a university in Brazil found five underlying factors that influence a student's choice of an undergraduate major:

(1) liking the activity;

(2) family influence;

(3) previous experience in the field;

(4) access to information about the field; and

(5) the state of the job market related to the field (Alchieri and Charczuk, 2003).

We observe that a "perceived ability or inability to perform well" was not among them.

Turner *et al.* (2002) and Adya (2005) found that a woman's choice of information technology careers is greatly influenced by when she first uses a computer, her parents' occupation(s), and the influence of such significant people in her life as mentors, teachers, and family members. However, women who have undergraduate degrees in IT fields such as information systems or computer science are not always influenced by taking an introductory programming course in high school, other high school computing courses, or by discovering a natural love of mathematics (Nielsen *et al.*, 2003; Von Hellens *et al.*, 2004). Many of the successful women in the Turner *et al.* (2002) study were first introduced to computers in grade school, and took seriously the subsequent encouragement or discouragement of their teachers in high school and college. Similarly, in their research at Carnegie Mellon University, Margolis *et al.* (2002) found that women enter information technology fields because they are successful in math and science, like problem solving and doing puzzles, or take an enjoyable programming class.

Misconceptions about computer and information science are plentiful and also appear to influence a woman's decision to major or not major in information systems. For example, some women perceive the major as one only involving "programming" or one with little room for creativity on the job (Craig *et al.*, 1998; Fisher *et al.*, 1997; Margolis *et al.*, 2002; Rasmussen and Hapnes, 1991). Similarly, some women perceive the information system major as a purely technical field, and therefore a career path lacking in opportunities to work with people. Because many women have a stronger interpersonal orientation than men, this perception is incompatible with many women's self concepts (Cross and Madson, 1997; Markus and Kitayama, 1991).

Some women also believe that careers in technology fields are difficult to reconcile with raising a family (Astin and Sax, 1996). For example, a study by Beyer *et al.* (2004) found that women were significantly more interpersonally-oriented and family-oriented than men, and that careers in computer science conflict with these orientations. These researchers also found that women tend to have lower confidence in male-dominated domains, despite the lack of objective evidence to justify any differentials in their abilities to do well.

2.2 Majoring in the information technology discipline

A body of research based on self-efficacy, an aspect of Bandura's (Bandura, 1986; Bandura *et al.*, 2001) Social Cognitive Theory, indicates that student beliefs about their ability to perform tasks successfully directly influence their choice of goals and subsequent task performance. For example, it is not surprising that students will choose a college major based on high-school courses in which they did well. Thus, if students experience success with computing, it is reasonable to assume that they may seek majors and careers in IT-related fields (McInerney *et al.*, 2006). It should be noted however that not all students have the same starting point with regard to technology and school.

In a survey by Weinberger (2004), college students in non-IT majors (including women-dominated majors such as biology, communications, English, psychology, and sociology, as well as economics, a major popular with both genders) were asked about their reasons for avoiding IT majors (defined as computer science, computer engineering, and electrical engineering) as well as their views about future careers. The most common reasons given by women students for avoiding these majors were that the coursework is uninteresting, difficult, and time consuming. The women thus felt that they would not enjoy the work in associated careers.

The Weinberger study also revealed that about one-third of the women (but none of the men) expressed concern about the classroom climate in IT courses. This suggests the perception of a gender-specific barrier, independent of whether or not these concerns are accurate (Rettenmayer *et al.*, 2007). This finding is echoed by Beyer *et al.* (2004) who reported that students – especially women – feel a high sense of isolation in technology courses.

2.3 Choices

Ultimately, the literature suggests that career preferences and lifestyle needs largely dictate why women do not choose technology-oriented careers (Reddock *et al.*, 2008). It also appears that the family-career trade-offs help explain the dearth of women in such fields as engineering, physics, computer science and in higher-level positions in non-math-related fields (Ceci and Williams, 2009). Women also perceive the workplace environment as a barrier to careers in computer engineering, computer programming, or electrical engineering (Weinberger, 2004). For at least some women, the choice to pursue alternate, non-technical careers may also be due to misperceptions, negative stereotypes, and lack of confidence, rather than to any real lack of interest in computing (Beyer *et al.*, 2004).

Finally, the Weinberger (2004) survey uncovered several points on which students were surprisingly unconcerned. In particular, very few students (and equal proportions of men and women) feared that choosing an IT related major would lead to social

ostracism, would fail to prepare them to do socially-useful work, or was incompatible with raising families. On the other hand, careers in technologically-based disciplines like information systems hold an aspect of dualism for women and are not perceived as fulfilling women's interpersonal orientation and desire to help others, having negative stereotypes, and are sometimes perceived to be difficult (Reddock *et al.*, 2008). In short, the average woman is unlikely to believe that she could succeed in the major, or would derive much satisfaction from a career in IT-related disciplines (Beyer *et al.*, 2004).

3. Model and methodology

Researchers have applied a variety of theories to model the decision-making process that students use in selecting a university major (Kimweli and Richards, 1999; Noel *et al.*, 2003). A particularly appealing one to us is the theory of reasoned action (TRA), which asserts that an individual's personal beliefs are important determinants of his or her subsequent actions (Ajzen, 1991; Ajzen and Fishbein, 1980).

TRA has been widely recognized as a practical framework for modeling rational human behavior and has proven valuable in examining such diverse phenomena as athlete training patterns (Anderson and Lavallee, 2008), criminal recidivism (Kiriakidis, 2008) and Internet purchasing activities (Barkhi *et al.*, 2008). Researchers have also used it to examine women's occupational orientations (Sperber *et al.*, 1980), accounting career choices (Felton *et al.*, 1995), career development (Terjesen *et al.*, 2007), and even the selection of a business major (Kimweli and Richards, 1999; Kuechler *et al.*, 2009; Noel *et al.*, 2003; Zhang, 2007). We therefore considered it a useful model for predicting female preferences in choosing a college major. The use of TRA to model what factors most influence females in choosing a college major is a potential contribution of this research study.

In applying TRA to the task at hand, it was necessary to decompose the ultimate action "intention to major in information systems" into two principle components:

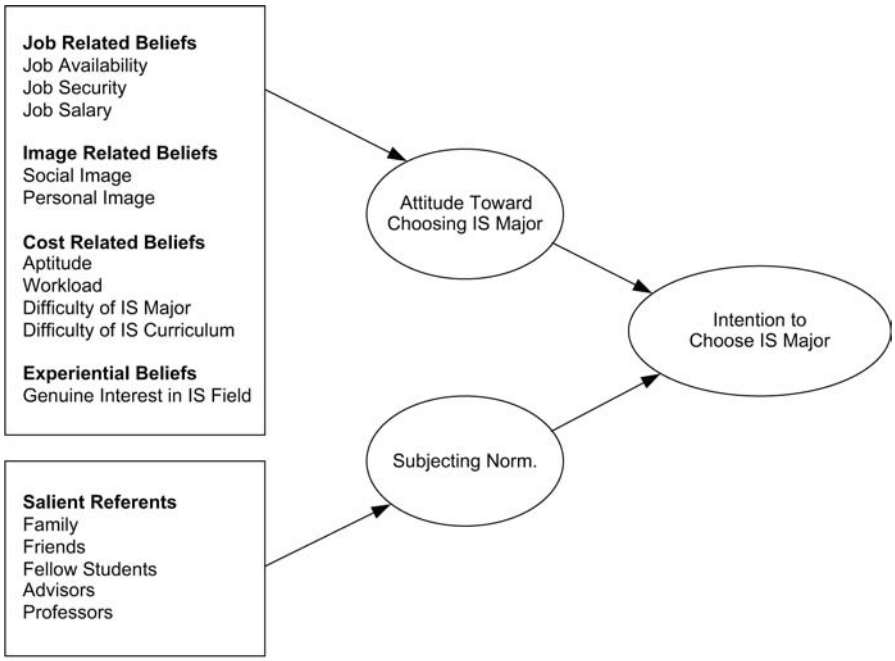
(1) attitudes towards choosing a major; and

(2) "subjective norm".

We further decomposed "attitude toward choosing an IS major" into job-related beliefs, image-related beliefs, cost-related beliefs, and experiential beliefs – i.e. the important influences thought to affect a student's choice of major. Similarly, we decomposed "subjective norm" into the individual salient referents that also influence a student's decision-making processes in this matter. Figure 1 summarizes the results of this effort – the application of the theory of reasoned action to the choice of IS major.

To test our model, we surveyed students taking a required management information systems (MIS) class offered at a public university in the western United States during 2009. Although participation in the study was voluntary, the majority of the students in six sections of the course completed the online web survey shown in Appendix 1 (Figures A1-A5). Many of the students responding to the survey had not yet formally declared a major and therefore represented a recruitment opportunity for our information systems department as well as an opportunity to learn their viewpoints in selecting a major.

The survey included three critical elements. The first section asked demographic questions such as age, gender, class rank, and (self-reported) grade point average. This allowed us to focus on female responses and to exclude all male data. The second and



Source: Zhang (2007)

Figure 1.
Theory of reasoned action major selection framework

third elements met our requirements to address questions related to the theory of reasoned action via Likert scale items and solicit reasons, individual comments, and explanations why women made their choices. We also wanted to distinguish between those students who had already committed to a major and those remaining uncommitted. We therefore added questions to our survey for each of these distinct groups.

3.1 Measurement model

In creating the measurement model for this study, we first analyzed our indicators to determine which to treat as "reflective variables" and which to treat as "formative variables." Reflective indicators depend on the construct, while formative measures cause the formation of, or changes in, variables (Haenlein and Kaplan, 2004; Bollen and Lennox, 1991). A common error when specifying structural equation models is to use reflective instead of formative indicators.

We fashioned our measurement model using the elements presented in Figure 1. The model requires measures of job-related beliefs, image-related beliefs, cost-related beliefs, experiential beliefs, and salient referents. Thus, for our survey, we categorized the following items as reflective indicators:

- job availability;
- job security;
- job salary;
- social image;

- personal image;
- aptitude;
- workload;
- difficulty of IT major;
- difficulty of IS curriculum; and
- genuine interest in IS.

Similarly, we classified the following influences as referents:

- family;
- friends;
- fellow students;
- faculty advisors; and
- professors.

These latter items are relatively independent variables that cause, form, or change a student's subjective norm, and which we therefore categorized as formative variables. Table I provides a description of these constructs.

3.2 Partial least squares analysis

A total of 392 (out of 484) students or 81 percent, completed our survey. We then used partial least squares (PLS) analysis to examine our survey data, following the structural equation modeling techniques of Gefen and Straub (2005). There were several reasons for this choice. One is that PLS is a structural equation modeling tool that supports both reflective and formative construct representation. Another is that PLS makes fewer demands on the underlying data distribution or sample size, and is also capable of analyzing both reflective and formative indicators (Chin, 1998a).

Indicator	Description
Reflective	
Job availability	The promise of job opportunities for IS graduates
Job security	The promise of high job security for IS graduates
Job salary	The promise of good salaries for IS graduates
Social image	Business people look up to or respect IS professionals
Personal image	Fear that IS professionals are "geeks" or "nerds."
Aptitude	Students think they are "good at" this concentration
Workload	The IS concentration requires a lot of study time
Difficulty of Major	Majoring in IS is difficult and will take a long time to complete
Difficulty of IS curriculum	Fear that IS courses are intensive, challenging, and demanding
Genuine interest in IS field	The belief that IS courses are interesting and likeable
Formative	
Family	The influence of family in choosing an IS concentration
Friends	The influence of friends in choosing an IS concentration
Fellow students	Other students recommend an IS concentration
Advisors	The student's advisor recommends an IS concentration
Professors	Influential professors recommend an IS concentration

Table I.
Description of constructs

Finally, and because of these advantages, PLS analysis is now a widely-accepted methodology in behavioral research and provides a robust way of analyzing survey data (Gefen and Straub, 2005; Chin *et al.*, 2003, Gefen *et al.*, 2000, Chin, 1998b).

This study used SmartPLS software to perform the partial least squares analysis (Ringle *et al.*, 2005). Again, our reflective indicators represent behavioral beliefs and our formative indicators represent independent referent items. To analyze the psychometric properties of the reflective measures, the software calculated the average variance extracted (AVE), composite reliability (ρ_c), and Cronbach's alpha (CA), latent variable correlations, and cross loadings. Table II reports our results.

Although there is no standard method for calculating statistically-acceptable composites, the generally-accepted rule is for composite reliability to be greater than 0.7 (Yi and Davis, 2003). In this study, the lowest composite reliability was for "workload" at 0.72 and we therefore concluded that all constructs demonstrated sufficient reliability.

Appendix 2 (Table AI) provides the latent variable factor loadings that we derived following Gefen and Straub (2005). We examined the convergent and discriminant validities of individual items by verifying that all loadings were greater than 0.7. With the exception of "workload" item 2, all loadings met discriminant and convergent measurement criteria. Overall, we believe that these results demonstrate good construct validity.

4. Results

Of the 392 students in our survey, 166 or 42.3 percent of them were female. Because we wanted to focus only on these females and why they do and do not choose to major in information systems, we eliminated the male responses from further consideration. The average age of these female students was 23.4 years with a standard deviation of 6.4 years. Their self-reported grade point average (GPA) was 3.28 on a 4.0 scale with a standard deviation of 0.39. Table III provides the class distribution of the females participating in our survey. Inasmuch as our survey participants were taking a junior-level class, it was not surprising that the majority of the respondents were either juniors or seniors.

Because past studies suggest that a student's choice of major is sometimes influenced by their advisor, we also inquired about this in our survey. Table IV

	AVE	ρc	CA
Aptitude	0.84	0.91	0.81
Attitude	0.87	0.93	0.85
Difficulty of curriculum	0.85	0.94	0.91
Difficulty of major	0.84	0.91	0.82
Genuine interest	0.83	0.94	0.90
Intention	0.91	0.95	0.90
Job availability	0.90	0.95	0.89
Job salary	0.91	0.96	0.91
Job security	0.91	0.96	0.91
Personal image	0.88	0.93	0.88
Social image	0.66	0.85	0.75
Workload	0.59	0.72	0.81

Table II. Average variance extracted, composite reliability and Cronbach's alpha

indicates that the majority of our female respondents had an advisor. Finally, we note that of the 166 female respondents in our survey, 142 of them indicated that they were not IS majors. The number of respondents for our structural analysis was therefore 142. We report demographics for the entire sample of participants. However, for the purposes of analysis, we focused on those females who were not IS majors in order to answer the question "why don't more women major in IS?"

Typically, not all survey respondents answer all questions – a problem that impedes further estimation procedures and a difficulty that we encountered here. Best practice using PLS calls for researchers to either replace all missing values with mean or regressed values, or to eliminate the associated observations from further consideration (Hayduk, 1987; Fan *et al.*, 2007; Chin *et al.*, 2003). We believe that "removing missing values" is the best course of action. After eliminating those responses with missing values, we used a bootstrap re-sampling method to generate 500 samples to estimate the path coefficients.

Figure 2 shows the β coefficients extracted via PLS and the p-values (statistical significance) for each path using t-tests. Overall, the model accounted for a substantive portion of variance in individual intention to choose information systems as a major ($R^2 = 0.52$). Student attitude toward choosing IS as a major accounted for a considerable amount of this variance ($R^2 = 0.42$).

4.1 Global fit measures of the TRA model

Tenenhause *et al.* (2005) suggest a global fit measure for partial least squares modeling – the GoF statistic ($0 < \text{GoF} < 1$). Researchers compute this statistic by taking the square root of the geometric mean of the average communality and the average R^2 of endogenous constructs:

$$\text{GoF} = \text{sqrt}(\text{average}(\text{AVE})^{*}\text{average}(\text{Rsq})).$$

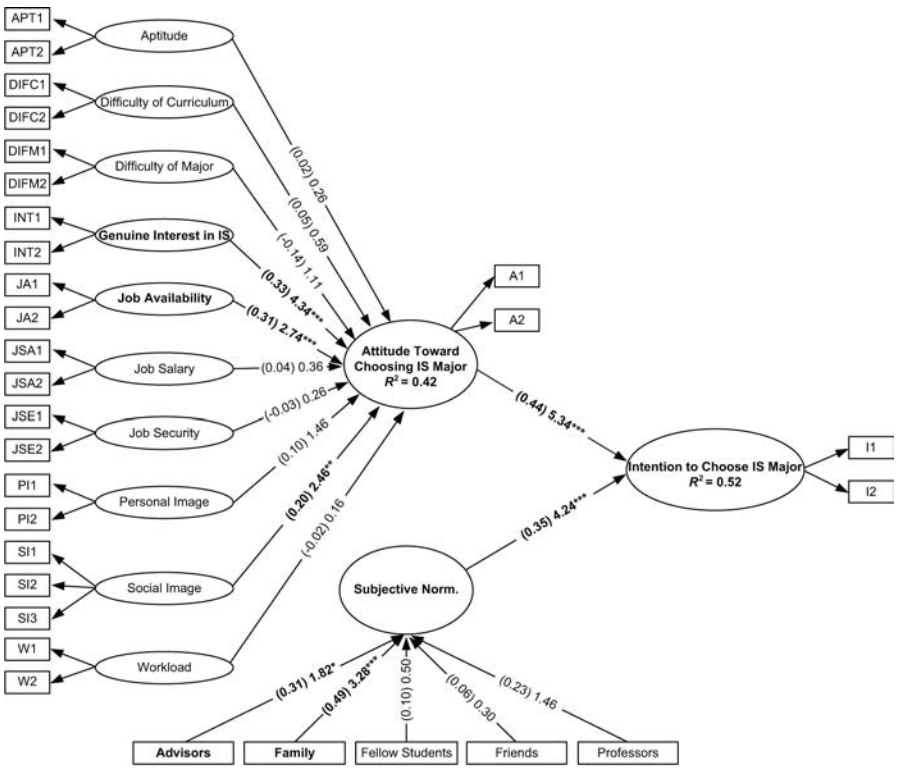
Wetzels *et al.* (2009) propose a cut-off value for communality of 0.5 as suggested by Fornell and Larcker (1981). The purpose of this modification to GoF was to establish

Table III.
Class rank of survey participants

Rank	*n*
Freshman	0
Sophomore	9
Junior	83
Senior	71
Graduate	1
(No response)	2
Total	166

Table IV.
Presence of an advisor

Have an Advisor?	*n*
Yes	107
No	35
Don't remember	24
Total	166



Notes: (β) *p*-value: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Figure 2.
PLS results for female non-IS majors

R^2 effect size based on Cohen (1988). By substituting 0.50 for the minimum average AVE, GoF criteria for small, medium and large effect sizes were set at the following values – GoFsmall = 0.1, GoFmedium = 0.25, and GoFlarge = 0.36. These values serve as baseline values for validating partial least square models globally. Calculating this value for our model produced a GoF = 0.48TRAModel which exceeds the GoFlarge = 0.36, allowing us to conclude that the TRA model performs well when compared to these baseline metrics (Wetzels *et al.*, 2009).

Table V provides statistical details for the results shown in Figure 2. Both a student's "attitude toward choosing information systems as a major" and "subjective norm" were significant in our model. The coefficient for "attitude toward choosing an IS major" was $\beta = 0.44$ with $p < 0.001$, while "subjective norm" was also significant with $\beta = 0.35$ and $p < 0.01$. In other words, we found that both attitudinal variables and subjective norms were important, positive influences on a woman's intent to major in the field of information systems.

In examining our results, we found that three behavioral beliefs were significant:

(1) a student's "genuine interest in information systems";

(2) "job availability"; and

(3) "social image".

	Original sample	Standard deviation	*t* statistics	*p*-value
Aptitude → Attitude	0.02	0.08	0.26	0.80
Attitude → Intention	0.44*	0.08*	5.34*	0.00*
Difficulty of curriculum → Attitude	0.05	0.09	0.59	0.56
Difficulty of major → Attitude	-0.14	0.12	1.11	0.27
Genuine interest → Attitude	0.33*	0.08*	4.34*	0.00*
Job availability → Attitude	0.31*	0.11*	2.74*	0.01*
Job salary → Attitude	0.04	0.10	0.35	0.72
Job security → Attitude	−0.03	0.12	0.23	0.82
Personal image → Attitude	0.10	0.07	1.46	0.15
Social image → Attitude	0.20*	0.08*	2.46*	0.02*
Subjective norm → Intention	0.35*	0.08*	4.24*	0.00*
Workload → Attitude	−0.02	0.11	0.16	0.88

Table V.
Statistical results

Note: * Statistically significant at $p < 0.05$

This is consistent with prior research showing that "genuine interest in IS" continues to be an important determinant in choosing an IS major (Kuechler *et al.*, 2009; Zhang, 2007). However, this factor is moderated by attitude toward choosing an IS major.

Neither the "difficulty of major" nor "aptitude" were significant determinants in choosing an IS major. What this suggests is that females who choose to major in information systems are undaunted by the difficulty of the curriculum. By inference, however, it may also suggest that those who don't major in IS are so influenced. This implication is consistent with casual "water-cooler comments" about the difficulty of majoring in IS overheard by the authors from students majoring in other subjects. This seems to be a fruitful avenue for further research.

With regard to job-related beliefs (job availability, job salary, job security, and perceived workload), only "job availability" strongly influenced the females in our survey in choosing an IS major. In contrast, "job salary", "job security", and "perceived workload" did not appear to significantly affect a female student's choice of IS major. The lack of significance for these variables may reflect a general student perception that, with a business degree, good jobs will be available regardless of their choice of major. If so, it also suggests another reason why more females do not major in information systems – they do not have to pursue such a major to be employable.

Finally, "social image" influenced female students' attitudes about their choice of major in our study. This says that females feel that societal views are more important in their choice of IS as a major than what influences them in choosing other majors. This matter also seems worthy of further study. "Personal image" was not significant and we think this means that "personal views" are not as important as those of others influencing their curriculum decisions.

Of the five formative indicators (advisor, family, fellow students, friends, and professors), only two of them appear to influence the choice of a business major:

(1) advisors; and

(2) family.

Both appear to contribute to student subjective norm and therefore affect the choice of an IS major. Table VI details the path value, *t*-test and *p*-value for the referent variables.

An item of particular interest to us was the influence of "professors" to our female respondents and their choice of major. Past literature suggests that the presence of a positive female role model makes a difference to women in making this decision (Guziewicz, 2009), but we found that this factor was only statistically significant at $p = 0.15$ level in our study. We wonder whether the lack of more female professors at our own university accounts for this finding and speculate that this variable might become more important if circumstances were different.

Finally, we note that in our study, "fellow students" and "friends" did not appear to strongly influence a female student's intention to choose an IS major. This is also a useful finding because it suggests that female peer groups do not strongly influence undecided women on their choice. It also suggests that women do not choose to major in information systems simply because other women major in it. Consequently, this finding has at least one recruiting implication: faculty interested in attracting females to the IS major are probably not going to have much success in telling current majors to "spread the word and tell your (female) friends".

5. Additional evidence and discussion

The results of our study suggest that the core reasons why women major in information systems are:

- they have a genuine interest in the subject;
- they believe that good jobs await them; and
- they believe that an information systems career is well respected (see again Table V).

As predicted by our literature review, it also appears that "the influence of family members" also positively impacts the decision to pursue this major. It is equally important to note what factors do not motivate women to major in information systems. Among the attitudinal factors that did not appear to be important were perceptions about:

- the difficulty of the curriculum;
- the difficulty of the major;
- job security in the field; and
- a student's own personal image.

	Original sample	Standard deviation	*t* statistics	*p*-value
Advisors → Subjective norm	0.31	0.14	1.82	0.07
Family → Subjective norm	0.49	0.14	3.28	0.00
Fellow students → Subjective norm	0.10	0.13	0.50	0.62
Friends → Subjective norm	0.06	0.16	0.30	0.76
Professors → Subjective norm	0.23	0.11	1.457	0.15

Table VI.
Referent variables: path, *t* statistic and *p*-value

This finding counters the claim that women do not choose an IS career path because "the IS major is too difficult for females" or because "information technology is only for men." It appears we have made some progress in the twenty-first century.

Perhaps of greater surprise to us were the subjective influences that did not appear to influence this decision. Among them were the influence of fellow students, friends, and even professors. This finding provides counter evidence to the assertion that women choose alternate majors because their friends or fellow students pursue other majors.

To examine these matters further, we also asked some direct questions in the second part of our survey. For example, one question asked "If you are not planning to major in information systems, why not? Here are some personal reasons that might apply to you. Please check all that apply." Table VII summarizes the answers to this question from our 166 female respondents, in order of frequency. The sum of the responses is greater than "166" because the participants could check more than one choice.

Table VII suggests that the most important reason why women do not major in information systems is because they prefer to major in something else. This finding is consistent with the most important reason we found why some women *do* major in IS – a preference for the area, perhaps due to a genuine interest in the subject. Also of interest to us was the second most frequent reason given in Table VII for not majoring in IS – respondents are not familiar with IS or are not familiar with it when they choose their major. This finding is also consistent with literature claiming that an early exposure to computers may positively affect the subsequent decision to major in IS. It also suggests an avenue of recruitment for IS faculty – the importance of informing incoming freshmen of the usefulness and availability of the IS major. We also speculate that the lack of the term "computers" in the official title of our particular major ("Information Systems") may have something to do with this lack of familiarity.

Our survey also left room for students to provide additional comments for this question. Table VIII provides some relevant comments. In Table VIII, responses 1-6 are examples of reasons why students prefer to major in something else. Reasons 7, 8, 9 and 10 are perhaps more interesting. Number 7 speaks more to a misconception about the usefulness of "learning" in alternate career paths than a misconception about IS, while reason 8 suggests that the writer perceives IS as a field with no artistry or room for creativity. Comment 9 is more concerned with working with a specific portion of society deemed exclusive from information systems and comment 10 perceives "personal fulfillment" to be at odds with IS. Finally, we feel that the last reason (15) is one commonly voiced by "effort minimizers" who want a degree but not necessarily an education.

Table VII.
Answers to the question "Why aren't you majoring in information systems?"

Count	Response
123	I prefer to major in something else
34	I am not familiar with IS or was not familiar with it when I chose a major
32	I am not good with computers
9	I think that IS courses are more difficult than the courses in other majors
5	I hate computers and want as little to do with them as possible
3	My parents suggested that an alternate major would be better for me
1	My friends think that alternate majors are better and I listened to them
1	Majoring in information systems would make me look like a geek

Response	Comment
Why female students prefer to major in something else	
1	Accounting will take me farther as my first major
2	I really like the major I chose, even more then IS
3	I've always had a strong liking for politics and social science
4	I am obtaining a degree for the job I already have
5	I feel my talent and passion are best executed in the science field
6	I feel my talents and passions are better executed in the science field
Misconception about learning	
7	I heard that when your job is in IT, you always have to take additional classes, because computers are always improving and changing. I don't want to be taking classes for the rest of my life
Artistic preference	
8	I prefer artistic thinking to logical thinking
Child preference	
9	I want to work with children and chose to minor in business administration
Unfulfilling misconception	
10	It does not seem fulfilling enough for me
Lack of fit with interest	
11	It does not really appeal to me
12	It would not fit my personality to be confined to a computer
13	Not interested in computer field
14	Not interested in computers and information technology
Effort minimization	
15	I would have to do 3 more credits and course load would be too much if I am planning to graduate soon

Table VIII.
Personal reasons to the open-ended question "Why aren't you majoring in IS?"

Finally, we asked students if they had any professional reasons for not majoring in information systems. Table IX summarizes the respondent answers to this question. As before, the most frequent response was "I do not consider the IS field to be a good choice for me." None of the other choices appeared to be particularly important, confirming that such matters as "job availability," "job image," "job security," and "the opinions of friends" were not substantive considerations in the decision not to major in information systems.

Count	Response
100	I do not consider the information systems field to be a good career choice for me
9	I do not think I could get a job in information systems when I graduate
7	Few employers really understand what information systems is about
7	Job security in the information systems field is a problem because so many information systems jobs are moving off shore
3	Few of my friends whose opinions I value really understand what information systems is about
2	I do not think there is good job security in the information systems field

Table IX.
Professional reasons why female students do not major in information systems

6. Summary and conclusions

At present, only two in every ten employees in the information technology work force are women, and current academic enrollments suggest that this is unlikely to change any time soon. Why don't more women major in information systems? The authors used:

- the responses from a survey of 166 female students;
- a model based on potential causative factors found in the literature;
- the theory of reasoned action;
- a partial least squares analysis; and
- direct comments and feedback from the students to answer this question.

Of the many explanatory variables we tested, three attitudinal variables ("genuine interest in the IS field", "job availability" and "social image") and one subjective norm ("the influence of family members") were statistically significant influences in a female's decision to major in information systems. By inference, one set of reasons why more women do not major in the field is because such factors as current job salaries or the promise of greater job security do not appear to be sufficiently high enough to sway more of them away from alternate majors.

We also asked students several open-ended questions about their decisions, one of which was "why aren't you majoring in information systems?" By far the most common answer was that another major interested our respondents more – an answer we feel is consistent with our finding that "genuine interest" is a key determinant in the choice of a university major.

Finally, our findings infer that there is much IS faculty can do to attract more females to the major and therefore to promising careers. Some authors suggest that universities, other institutions and companies encourage females by creating options for women with hard-science talents who want to pursue STEM-intensive careers (Ceci and Williams, 2009). Teachers and academic institutions should also address the misconception that information technology disciplines are only for social loners or computer geeks and stress that these careers are respectable and valued. They can also stress the idea that many jobs in the information technologies require individual initiative and creativity, and that new social media and associated technologies benefit from strong interpersonal skills.

Similarly, it seems useful for IT recruiters to move discussions away from questions about balancing family with career or at least counter them by noting that other career paths are likely to be no different (Ahuja, 2002). The coursework required to prepare for technology-related careers is challenging in nature, yet it is surprising to find that the work required to become a computer programmer or engineer is perceived by many young women as more difficult than that required to become a surgeon (Weinberger, 2004). Further study of the formation and accuracy of perceptions about the difficulty of information technology related coursework is needed.

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Appendix 1. Survey

Questions about your major:

Do you have an advisor?

- ☐ Yes
- ☐ No
- ☐ Don't Remember

If you answered yes, what is your Advisors Name

Which of these best describes your choice of a major at UNR? Pick one choice below.

- ◯ I have already chosen a major in information systems.
- ◯ I am considering majoring in information systems, but have not committed to this idea yet.
- ◯ I have already committed to a major other than information systems.
- ◯ I am considering other majors but have not committed to one yet.

IS major or considering an IS major

If you are an information systems major or are considering becoming one, why did you choose or think you might choose to become one?
Check all that apply.

- ☐ Interesting subject.
- ☐ I am good with computers.
- ☐ I expect to get a good job when I graduate.
- ☐ My family members suggested the idea of majoring in information systems.
- ☐ My friends suggested the idea of majoring in information systems.
- ☐ I consider the field of information systems to be a good career choice for me.
- ☐ I think there is good job securityin the information systems field.

Other (please specify)

Not planning to major in IS for personal reasons

If you are not planning to major in information systems, why not? Here are some personal reasons that might apply to you.
Please check all that apply.

- ☐ I am not good with computers.
- ☐ I prefer to major in something else.
- ☐ I am not familiar with information systems or wasn't familiar with it when I chose a major.
- ☐ My parents suggested that an alternate major would be better for me.
- ☐ My friends think that alternate majors are better and I listened to them.
- ☐ I think that information systems courses are more difficult than the courses in other UNR majors.
- ☐ Majoring in information systems would make me look like a geek.
- ☐ I hate computers and want as little to do with them as possible.

Anything else? Please indicate so here.

Figure A1.
Survey questionnaire

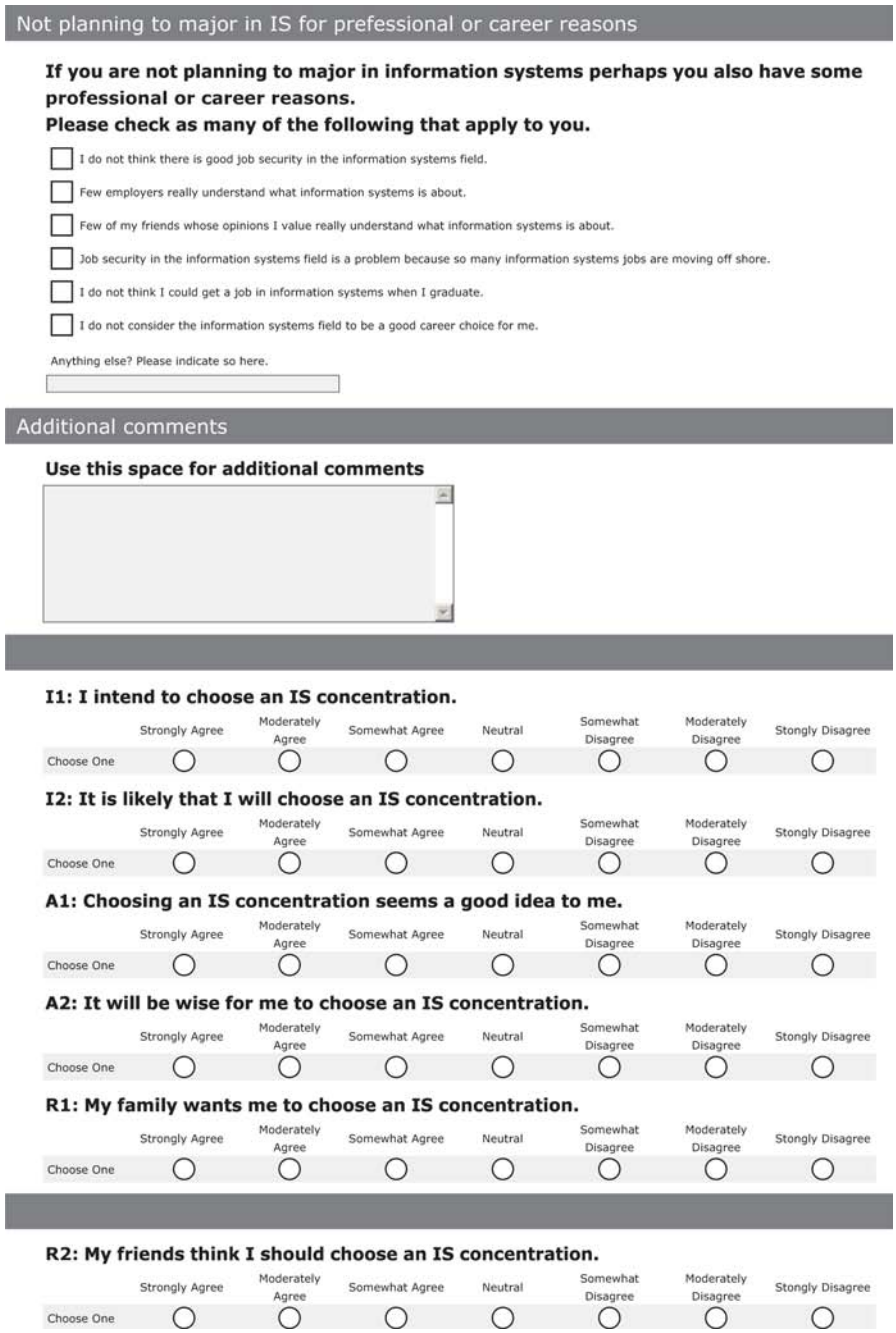


Figure A1.

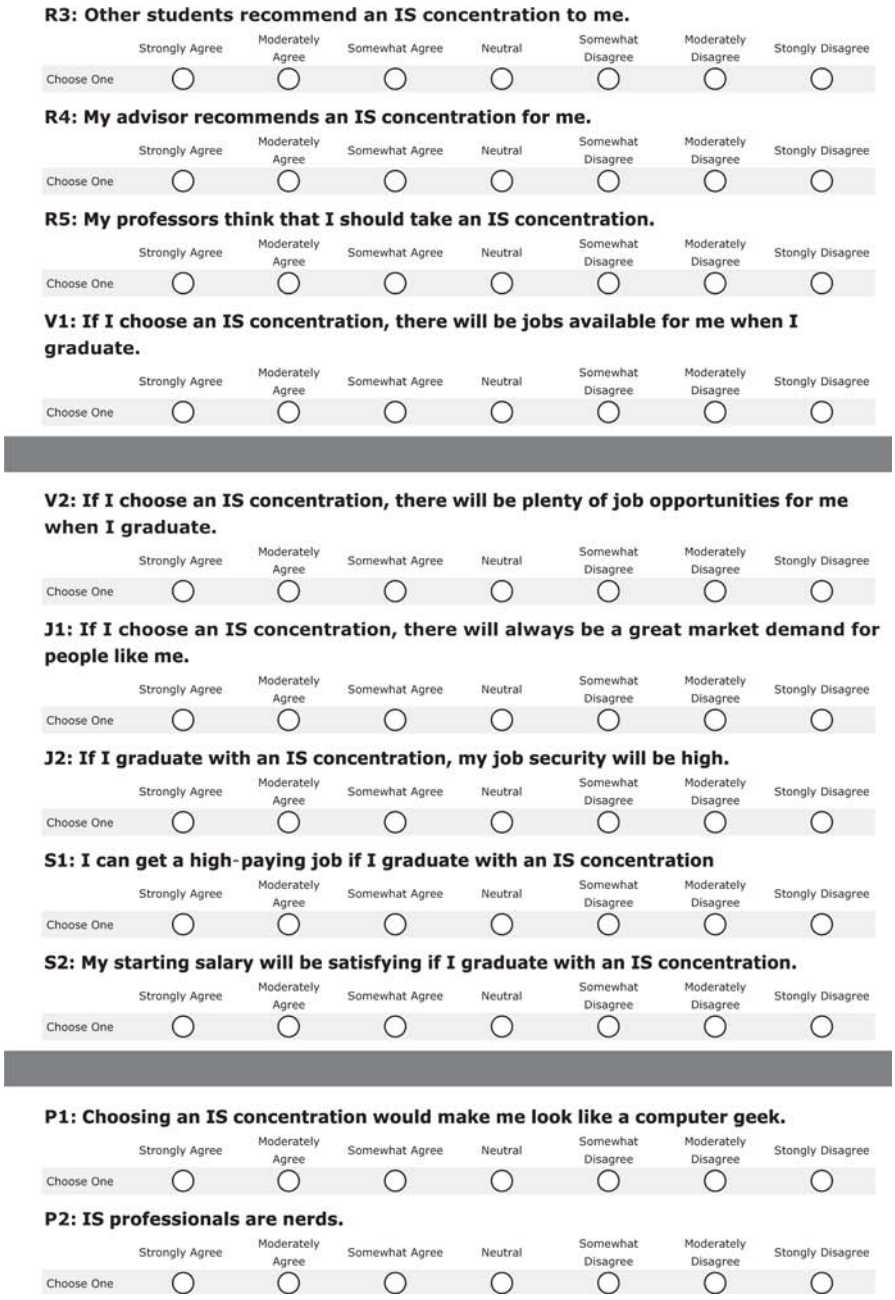


Figure A1.

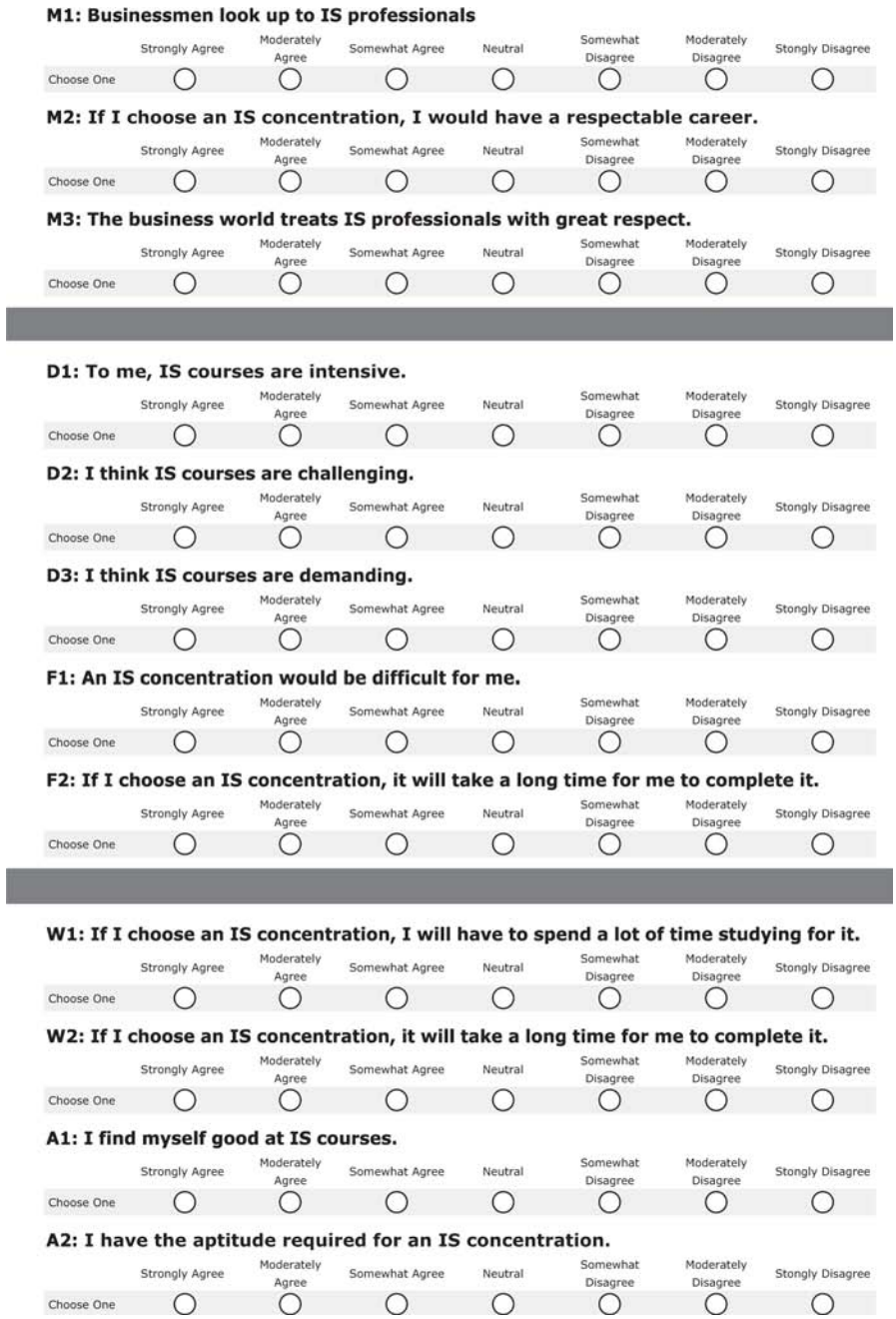
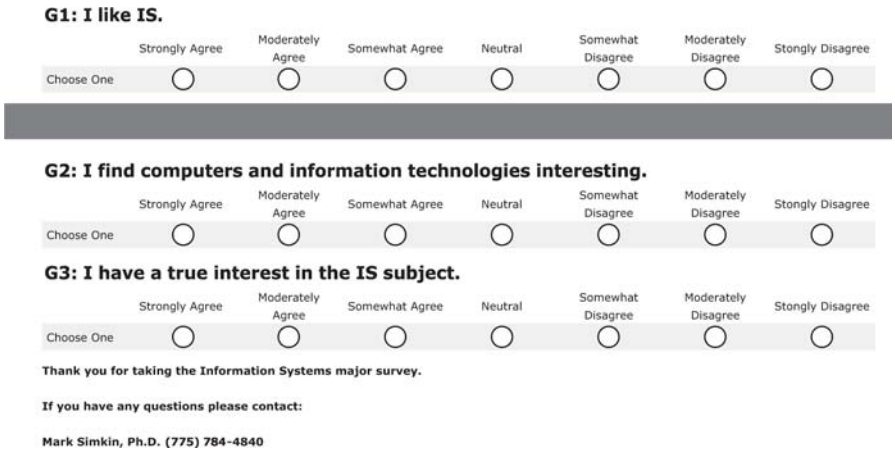


Figure A1.



G1: I like IS.

	Strongly Agree	Moderately Agree	Somewhat Agree	Neutral	Somewhat Disagree	Moderately Disagree	Stongly Disagree
Choose One	○	○	○	○	○	○	○

G2: I find computers and information technologies interesting.

	Strongly Agree	Moderately Agree	Somewhat Agree	Neutral	Somewhat Disagree	Moderately Disagree	Stongly Disagree
Choose One	○	○	○	○	○	○	○

G3: I have a true interest in the IS subject.

	Strongly Agree	Moderately Agree	Somewhat Agree	Neutral	Somewhat Disagree	Moderately Disagree	Stongly Disagree
Choose One	○	○	○	○	○	○	○

Thank you for taking the Information Systems major survey.

If you have any questions please contact:

Mark Simkin, Ph.D. (775) 784-4840

Figure A1.

Appendix 2

Table AI.
Factor loadings

	Aptitude	Attitude	Difficulty of curriculum	Difficulty of major	Genuine interest	Intention	Job availability	Social image	Personal image	Subjective norm	Job salary	Job security	Workload
Apt1	0.91	0.28	−0.12	−0.36	0.43	0.12	0.18	0.27	−0.18	0.28	0.13	0.22	−0.17
Apt2	0.92	0.29	−0.04	−0.35	0.42	0.24	0.11	0.13	−0.02	0.32	0.08	0.15	−0.25
Att1	0.27	0.93	0.10	−0.11	0.44	0.62	0.38	0.41	0.02	0.61	0.30	0.38	0.07
Att2	0.31	0.94	0.21	0.01	0.48	0.65	0.45	0.38	0.06	0.64	0.39	0.41	0.13
DifCour1	−0.08	0.16	0.93	0.49	0.19	0.20	0.19	0.19	0.21	0.31	0.21	0.20	0.49
DifCour2	−0.14	0.17	0.94	0.54	0.13	0.22	0.24	0.23	0.19	0.30	0.26	0.26	0.55
DifCour3	0.00	0.12	0.89	0.44	0.15	0.19	0.23	0.23	0.20	0.31	0.23	0.24	0.51
FDifCurr1	−0.38	−0.06	0.54	0.95	−0.18	−0.02	0.23	0.21	0.18	0.00	0.24	0.23	0.61
FDifCurr2	−0.31	−0.04	0.44	0.88	−0.12	0.02	0.12	0.17	0.16	−0.02	0.16	0.14	0.42
GenInt1	0.51	0.50	0.07	−0.26	0.92	0.39	0.20	0.28	−0.04	0.42	0.17	0.25	−0.08
GenInt2	0.36	0.39	0.26	−0.04	0.90	0.33	0.18	0.36	−0.07	0.31	0.18	0.23	0.04
GenInt3	0.38	0.45	0.16	−0.13	0.92	0.45	0.11	0.30	−0.01	0.39	0.17	0.20	−0.05
Int1	0.21	0.63	0.20	−0.01	0.42	0.95	0.18	0.31	0.12	0.59	0.25	0.23	0.10
Int2	0.17	0.66	0.22	−0.01	0.40	0.96	0.26	0.26	0.11	0.64	0.32	0.22	0.12
JbSec1	0.24	0.39	0.27	0.20	0.29	0.23	0.77	0.46	0.00	0.36	0.67	0.95	0.31
JbSed2	0.14	0.41	0.22	0.21	0.19	0.22	0.80	0.46	0.03	0.32	0.75	0.96	0.33
MSocImg1	0.18	0.41	0.20	0.11	0.29	0.29	0.20	0.82	−0.01	0.29	0.23	0.26	0.18
MSocImg2	0.20	0.33	0.19	0.20	0.27	0.22	0.49	0.82	−0.10	0.30	0.46	0.54	0.47
MSocImg3	0.14	0.25	0.17	0.25	0.26	0.19	0.38	0.79	−0.14	0.13	0.43	0.41	0.34
PerImg1	−0.07	0.03	0.18	0.11	−0.07	0.14	−0.04	−0.07	0.89	0.08	0.03	0.03	0.12
PerImg2	−0.11	0.05	0.22	0.21	−0.03	0.10	−0.01	−0.09	0.98	0.07	0.07	0.01	0.14
RAdv4	0.30	0.53	0.29	−0.02	0.35	0.55	0.32	0.34	−0.05	0.85	0.24	0.28	0.18
RFam1	0.23	0.57	0.32	0.05	0.32	0.57	0.31	0.16	0.21	0.88	0.24	0.28	0.13
RFeStu3	0.34	0.57	0.18	−0.08	0.45	0.49	0.33	0.37	−0.01	0.76	0.24	0.37	0.08
RFri2	0.34	0.57	0.30	−0.03	0.43	0.54	0.29	0.33	0.08	0.84	0.26	0.33	0.18
RProf5	0.29	0.57	0.22	−0.06	0.34	0.48	0.34	0.28	−0.06	0.75	0.21	0.32	0.13
SJbSal1	0.09	0.38	0.27	0.22	0.18	0.31	0.68	0.41	0.12	0.30	0.96	0.74	0.31
SJbSal2	0.13	0.33	0.21	0.21	0.18	0.25	0.67	0.43	−0.02	0.23	0.95	0.69	0.33
VJbAv1	0.17	0.44	0.19	0.17	0.16	0.21	0.95	0.39	−0.04	0.37	0.61	0.70	0.29
VJbAv2	0.14	0.40	0.26	0.21	0.17	0.22	0.94	0.42	0.00	0.36	0.73	0.87	0.29
WrkLoad1	−0.28	0.08	0.59	0.71	−0.06	0.10	0.30	0.37	0.16	0.15	0.32	0.33	0.97
WrkLoad2	−0.33	−0.02	0.44	0.81	−0.09	0.04	0.17	0.16	0.16	0.05	0.16	0.18	*0.49*

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