Student Motivational Profiles in an Introductory MIS Course: An Exploratory Cluster Analysis

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Abstract

This study profiles students in an introductory MIS course according to a variety of variables associated with choice of academic major. The data were collected through a survey administered to 12 sections of the course. A two-step cluster analysis was performed with gender as a categorical variable and students' perceptions of task value (interest, importance, and utility) in the domain of information systems, self-efficacy regarding computer and applications, and attitudes towards the use of computers. Five clusters were found. Clusters fell along gender lines with one all-male cluster showing positive motivation on all dimensions, one all-female cluster showing positive motivation except for computer self-efficacy, one all-male cluster with negative motivation except for computer efficacy, one all-female cluster with negative motivation except for applications efficacy, and one IT-averse cluster with very low scores on all aspects of motivation. All MIS majors in the sample were in the two clusters showing positive motivation. A subsequent profile analysis was carried out to examine the variation of other characteristics in different student segments that were not included in the cluster analysis such as number of IS courses in high school, attitude toward change, and influence of salient referents on the choice of an academic major.

Keywords: IS majors, Choice of major, Gender, Gender gap, Cluster analysis, Introductory MIS course

INTRODUCTION

Declining enrollments in MIS majors have been a concern for the last decade. The number of bachelor degrees in computer sciences increased sharply from 1998 to 2004, then dropped considerably through 2008, and remained flat in 2009. Of all the bachelors degrees awarded, 2.99% were in the computer sciences in 2000, 4.23% in 2004, and 2.37% in 2009 (National Science Board, 2012). The gender gap persists but may be improving slightly: the number of incoming undergraduate women interested in majoring in Computer Science decreased by 79% between 2000 and 2009 (NCWIT, 2009), and by 64% between 2000 and 2011 (NCWIT, 2013). Figure 1 (Appendix) shows that the percentage of female recipients of undergraduate degrees in the computer sciences dropped from 28.04% in 2000 to 17.69% in 2008 based on statistics by the National Science Boards. In 2011, 18% of 2011 Computer Sciences and Information Sciences undergraduate degree recipients were female (NCWIT, 2013). Margolis and Stockard (2005) concluded that "the fields of IT and computer science have in effect become gendered 'male' ".

Prior research has identified many factors that affect a student's choice to major in IS including genuine interest, salient referents (family, friends), self-efficacy, outcome expectations, job availability, social image, difficulty of the major, social support, and students' stereotypes of IS professionals. Research further suggests that gender plays "an important yet complicated role in affecting students' intentions to choose an IS major" (Zhang, 2007, p. 455). One frequently cited phenomenon for the underrepresentation of women in IT is the "incredible shrinking pipeline" which represents the ratio of women involved in computer science from high school to graduate school (Camp, 1997), and which disproportionately and at all stages leaks female students. High school students with interest and aptitude in IT choose another major, and students majoring in IT change their mind before graduation and select another area of study (Blickenstaff, 2005; Gürer & Camp, 2001).

This study seeks to gain fresh insights regarding low enrollments and low representation of women in the information systems major by using cluster analysis to segment and then profile business students in an introductory management information systems course based on motivational belief variables identified in prior research. Specific questions pursued in this paper are:

- Which student groupings emerge based on similarity in gender and students' motivational beliefs using perceptions of task value (interest, importance, and utility) in the domain of information systems, self-efficacy regarding computer and applications, and attitudes towards the use of computers?
- How do groupings identified by cluster analysis vary based on other student characteristics not included in the cluster analysis, specifically: age, number of IS high school courses, degree of parental and non-parental influence on the academic major choice, perceived task difficulty of the MIS course, attitude towards change, and distribution of academic majors?

This paper is structured as follows. The literature review provides an overview of the factors affecting major choice including motivational beliefs (interest, utility and importance, self-efficacy), attitudes towards computer use, attitudes towards change, gender, and the value of an introductory IS course. The research methodology section describes the sample and measures, and provides details on the factor and cluster analyses employed in this study. Cluster descriptions based on the cluster means of the clustering variables are provided in the results section along with a profile of clusters using variables not including in the clustering process.

The final section discusses results in light of extant research, and concludes with practical implications and methodological contributions of the present study.

LITERATURE REVIEW

Interests not only affect the choice of entering a major (Porter & Umbach, 2006), but also persisting in it (Allen & Robbins, 2008). Not surprisingly, genuine interest in IS consistently emerges as the most important factor affecting students' intentions to major in IS (e.g., Akbulut-Bailey, 2012; Downey, McGaughey, & Roach, 2011; Kuechler, McLeod, & Simkin, 2009; Walstrom, Schambach, Jones, & Crampton, 2008; Zhang, 2007). Other factors include salient referents (family, friends), perceptions of self-efficacy, outcome expectations, job availability, social image, difficulty of the major, social support, and students' stereotypes of IS professionals. In the context of IT, self-efficacy usually refers to "an individual's perceptions about her or his computer-related and IT-related abilities" (Brinkley & Joshi, 2005, p. 27).

Research also suggests that students' interests and intentions to choose an IS major are affected by gender. Zhang (2007) found female students to be less interested in IS than male students, and more affected by their beliefs about job availability than male students (Zhang, 2007). Women also report lower levels of computer self-efficacy than men (Johnson, Stone, & Phillips, 2008). A recent study by Croasdell, McLeod, and Simkin (2011) found three core reasons for women majoring in IS: genuine interest, prospect of good jobs, and belief that an information systems career is well respected. The same study found that difficulty of the curriculum / major and salient non-parental referents (fellow students, friends, and professors) did not play a significant role in the choice of IS as a major. Primary reasons for female students not choosing IS included preference for another major and not being familiar with IS when deciding on a major.

The introductory IS course has also been viewed as a vehicle for attracting students to the IS major by dispelling negative stereotypes about the profession and increasing interest in the field. Akbulut-Bailey (2013), for example, found that student perceptions about IS professionals became significantly more positive by then end of the semester. The course can also generate student interest by fostering a sense of self-efficacy and instilling expectations of positive outcomes (e.g., peer admiration, good salaries) (Akbulut-Bailey and Looney, 2007). Interest generated by specific environmental stimuli (e.g., emerging in educational settings such as taking an introductory IS course) is referred to as situational interest (Hidi & Baird, 1988). It differs from individual interest, which is activated internally and of enduring personal value (Schiefele, 1999), remaining relatively stable from age 12 or eighth grade to age 40 for both males and females (Low, Yoon, Roberts, and Rounds, 2005). Particularly relevant from an educator's perspective is situational interest which is changeable, partially under the control of teachers (Schraw, Flowerday, & Lehman, 2001) and, if maintained, may lead to a well-developed individual interest (Krapp, Hidi, & Renninger, 1992).

Enrollment decisions in multiple academic domains have also been related to the subjective task value component in the Eccles et al. (1983) expectancy-value model of achievement (Eccles & Wigfield, 1995; Eccles and Wigfield, 2002). Of particular interest in the context of this research are three components of the perceived overall value of any specific task: 1. intrinsic value / interest, or how much the individual is interested in and likes the task; 2. attainment value, or the importance of doing well on the task; and 3. utility value, or the usefulness of the task for achieving future goals (Eccles & Wigfield, 1995). Measures for assessing task value perceptions in the domain of mathematics are provided in Eccles and Wigfield (1995). Focusing on the course level, the Motivated Strategies for Learning Questionnaire (MSLQ) includes a subscale to assess task value beliefs or judgments of how interesting, useful, and important the content of a course is to a student (Duncan & McKeachie, 2005).

Given that IT is characterized by rapid change, a plausible dimension to include in understanding IT major selection factors are attitudes towards change. Tolerance for ambiguity, for example, has been found to significantly affect major selection in a study comparing traditional accounting students with accounting information systems (AIS) majors (Lamberton, Fedorowicz, & Roohani, 2005). Specifically, students with low ambiguity tolerance were more likely to major in accounting versus AIS. The short 7-item form of the Change Seeker Index (CSI) developed by Steenkamp and Baumgartner (1995) appears to be a promising measure for assessing such attitudes.

RESEARCH METHODOLOGY

Sample and Measures

A self-report paper-based questionnaire was administered to 253 students during the last two weeks of the Spring 2013 semester in 12 sections of an introductory MIS course required of all business students. Participation was voluntary, and 210 students completed the survey. Cases with many missing values and/or inappropriate answers (e.g., all questions were marked as strongly disagree) were excluded for further analysis leaving 195 valid responses.

Apart from demographic items (age, gender, classification, international student, declared academic major, parent working in information systems), the questionnaire included Likert-scale items from validated instruments for the following dimensions: task value perceptions (interest, importance, utility), perceived task difficulty, computer self-efficacy, applications self-efficacy, attitudes towards computer use, salient influences on major choice, and attitude towards change (change seeking). Details regarding the number of items per scale, sources, and measurement are provided in Table 1 (Appendix).

Factor Analyses

Factor analyses were conducted with SPSS Statistics 21 using the principal components extraction method and Varimax rotation. The goal of the first analysis was to obtain dimensions for use in cluster analysis based on the 31 motivational belief variables measuring task value, self-efficacy, and attitudes described earlier. Following Hair, Black, Babin and Anderson (2010), problematic variables were systematically evaluated for possible deletion based on their factor loadings and conceptual coherence. The model was respecified twice to exclude the following two items that did not load highly on any factor: the task difficulty item “I found concepts easy to understand”, and the computer self-efficacy item “Use a computers to display or present information in a desired manner”. The final five-factor solution for the remaining 29 items shown in Table 2 met the goals of interpretability, and has acceptable loadings of greater than ± .50 for all factors (Hair et al., 2010). The five factors explain 69.92% of the total variance in the original variables, with Factor 1 (Interest) accounting for 40.26%, Factor 2 (Utility) for 12.89%, Factor 3 (Computer Self Efficacy) for 7.15%, Factor 4 (Applications Self-Efficacy) for 5.57%, and Factor 5 (Computer Use Attitudes) for 4.05%. Bartlett's sphericity test (4511.146, df=406, Sig. =.000) and the Kaiser-Meyer- Olin measure of sampling adequacy (KMO = .910) indicate that the factor analysis was appropriate (Hair et al., 2010; Mertler & Vannatta, 2002). Cronbach's alpha was computed to assess the internal reliability for each factor. Table 2 shows that all constructs have values greater than the minimum of .70 required for reliability (Hair et al., 2010). Summated scales were created by averaging the items with high loadings for each factor.

The second analysis used 9 items from Downey (2010) representing influences on a student's choice of academic major. The resulting two factors shown in Table 3 (Appendix) explain 67.04% of the total variance in original variables. Factor 1 representing the non-parental influences accounts for 47.71% of the total variance, Factor 2 consisting of the parental influence items accounts for 19.34% of the variance. Bartlett's sphericity test (956.414, df=36, Sig. =.000) and the Kaiser-Meyer- Olin measure of sampling adequacy (KMO = .774) indicate that the factor analysis was appropriate (Hair et al., 2010; Mertler & Vannatta, 2002). Cronbach's alpha was computed to assess the internal reliability for each factor. Cronbach's alpha for the parental influence items was .928, and .842 for the non-parental influence items, thus exceeding the minimum of .70 required for reliability (Hair et al., 2010). Summated scales were created by averaging the items for each factor.

The third analysis used the seven items comprising the short form of the Change Seeker Index (Steenkamp & Baumgartner, 1995). In the initial two-factor solution, the two reverse-scored items indicating a preference for little change loaded separately on their own factor. Rerunning the analysis without these two items resulted in one factor (change seeking) explaining 66.23% of the total variance. Bartlett's sphericity test (491.363, df=10, Sig. =.000) and the Kaiser-Meyer- Olin measure of sampling adequacy (KMO = .842) indicate that the factor analysis was appropriate (Hair et al., 2010; Mertler & Vannatta, 2002). Cronbach's alpha for this scale was .866, exceeding the minimum of .70 required for reliability (Hair et al., 2010). A summated scale was created by averaging the items for this factor.

Cluster Analysis

Cluster analysis with SPSS's data mining tool Modeler 15.0 was then conducted to profile business students in the sample using the standardized summated scales (Z-scores) from the first factor analysis and the categorical gender variable (0 = male, 1 = female). The two-step clustering method within the auto-cluster modeling node was chosen because of its ability to handle both continuous and categorical data. The minimum number of clusters were specified as 2, 3, 4, and 5. The algorithm used the Log-likelihood distance measure and Schwarz's Bayesian Criterion (BIC) to arrive at three cluster solutions. The 5-cluster solution appeared the most appropriate because it had the highest Silhouette coefficient (.404) and was very interpretable per Figure 2 which shows cluster means of the Z-scores as a column chart. Ranging between -1 and 1, the silhouette coefficient is an intrinsic measure of clustering quality based on both cohesion within a cluster and separation between the clusters (Han, Kamber, & Pei, 2012). A coefficient of less than 0.2 indicates that the data do not exhibit cluster structure. The cluster quality indicator in SPSS Modeler showed that the Silhouette coefficient of 0.404 represented a fair cluster solution.

RESULTS

Cluster Descriptions

As shown in Figure 2 and Table 4 (Appendix), students in Cluster 1 have above average Z-scores on all dimensions. Students in this all male cluster have the greatest interest in information systems, perceive the greatest utility and importance of information systems, self-report the highest computer efficacy, and appear to have the most positive attitude towards using information systems. Not surprisingly, 71.43% of the IT majors in this sample are in this cluster.

Cluster 2 represents the male students that score below average on all motivational dimensions except percpetions of computer self-efficacy. One student in this cluster has declared MIS as an academic major.

Cluster 3 includes a small IT-averse segment of students (4.1%) whose Z-scores are all negative and considerably below average, particularly with respect to computer and applications efficacy and attitudes towards using computers. This cluster, consisting of 14.3% females, features the second-lowest cluster means for interest in IS and perceived utility and importance. There are no MIS majors in this cluster.

Cluster 4, an all-female cluster, also has no students majoring in MIS. Outstanding features of this cluster are the highest negative Z-scores for both interest in IS and perceived utility and importance. Female students in the cluster also report below average computer self-efficacy. At the same time, applications self-efficacy is higher than average in this cluster.

Cluster 5, the second all-female cluster, shows above average scores for interest, utility and importance, applications efficacy, and attitudes towards computer use. The only dimension with slightly below average scores is computer efficacy. Three students in this cluster are MIS students representing 21.43% of all MIS students in this sample.

Profiling Clusters on Other Student Characteristics

A profile analysis of the 5 clusters to examine possible patterns and variation of other student characteristics using standardized scores (Z-scores) is also shown in Table 4 (Appendix). Of particular interest to this study are clusters 1 and 5 who contain the MIS students. Male students in Cluster 1 were the most IT-prepared based on the number of high school IS classes taken. Cluster 1 is the only one with a positive Z-score on this variable. Female students in Cluster 5 were below average in terms of high school IS classes, even more than non-interested male students in Cluster 2. Clusters 1 and 5 are similar regarding perceived easiness of the class. Both clusters displayed positive Z-scores on this item, with males having a considerably higher score though than female students in Cluster 5 (.576 versus .125). Students in Clusters 1 and 5 had comparable above average scores for change seeking, indicating more positive attitudes toward change than present in the other three clusters. Clusters 1 and 5 are also comparable regarding the influence of parents on a student’s choice of major: Z-scores in this cluster are below average on this variable, with the score for female students in Cluster 5 being more negative. At the same time, the all-female Cluster 4 features the highest positive Z-score for the influence of parents on a student’s major selection. Finally, salient referents such a friends, peers, and professors are more important to males in Cluster 1 than to females in Cluster 5. Scores for students in Cluster 1 are slightly above average on this variable, while scores for female students in Cluster 5 are the lowest and negative (-.125). Of interest is also the distribution of non-IS business majors across clusters. Cluster 1, the all-male cluster with above average scores on all the IT-related motivational factors also includes the highest percentage of students majoring in economics (44.44%), entrepreneurship (35.29%), and management (39.13%). Of the accounting and marketing students in this sample, 45.45% and 38.71% respectively are in Cluster 5, the all-female cluster with above average scores on the IT-related factors.

DISCUSSION AND CONCLUSIONS

The present study builds on extant research on factors influencing the selection of IS as an academic major. Approximately 57% of students in the introductory MIS course surveyed, specifically those in Clusters 1 and 5, show a moderate to strong degree of interest in information systems. Students in these clusters also strongly agree that information systems and the content of the course are useful and important. Not surprisingly, clusters developed along gender lines. Consistent with Zhang (2007) female students were less interested in IS than male students. Similarly, and consistent with Johnson et al. (2008), female students also reported lower levels of computer self-efficacy than their male counterparts. This may be the result of having taken a greater number of IS courses at the middle and high school level. However, all female students in the sample had positive Z-scores on the applications self-efficacy dimension, with the IT-friendly female Cluster 5 outscoring the male students in the IT-friendly Cluster 1. Students in Clusters 1 and 5 also displayed the greatest comfort with change as illustrated by their scores on the Change Seeker Index. The IT-averse cluster 3 had the lowest mean on this variable. Female students in Cluster 5 appear to be more independent from their parents in their choice of major than male students in Cluster 1. IT-averse students in Cluster 3 were least influenced by their parents.

From a methodological perspective, the cluster analysis along motivational dimensions performed in this study, and subsequent profiling of clusters on other student characteristics of interest is a novel approach to researching the choice of information systems as a major and the underrepresentation of female students in this field. A search of the IS literature revealed one other study that employed cluster analysis. That study explored student segments by clustering on various dimensions of academic abilities for the MIS department of a Turkish university (Darcan & Badur, 2012). Olaussen and Bråten (2004) used cluster analysis on personal interest, mastery goals, task value, and self-efficacy to understand and explain the change in student motivational profiles with a sample of 78 MBA students at the Norwegian School of Management.

From a practical perspective, understanding the motivational beliefs of students within a given cluster may be useful in planning and tailoring course material for an introductory IS course, and in generating situational interest, particularly amongst female students (those in Cluster 5) to increase enrollments in the MIS major. These students appear to be independent thinkers that are not as influenced by salient referents (both parents and others) as students in other clusters. Analyses such as these may also assist in identifying students who may be more likely to switch majors.

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APPENDIX

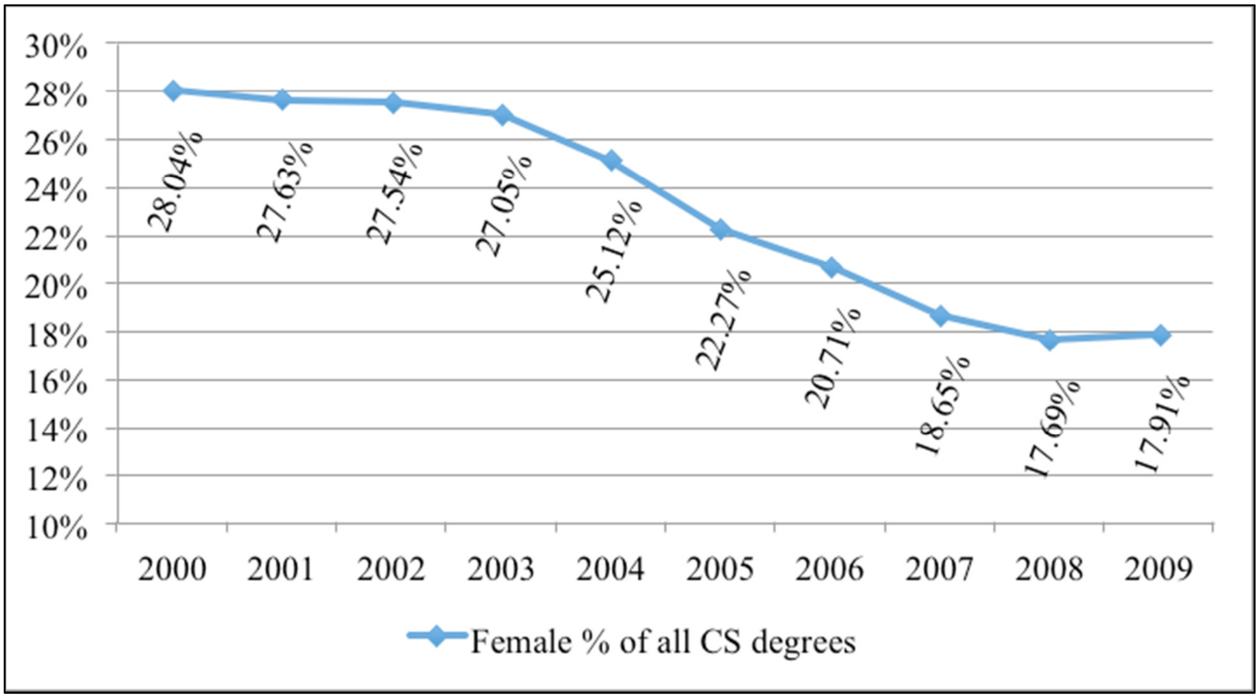

Figure 1. Female % of bachelors' degrees in the computer sciences (2000 – 2009)

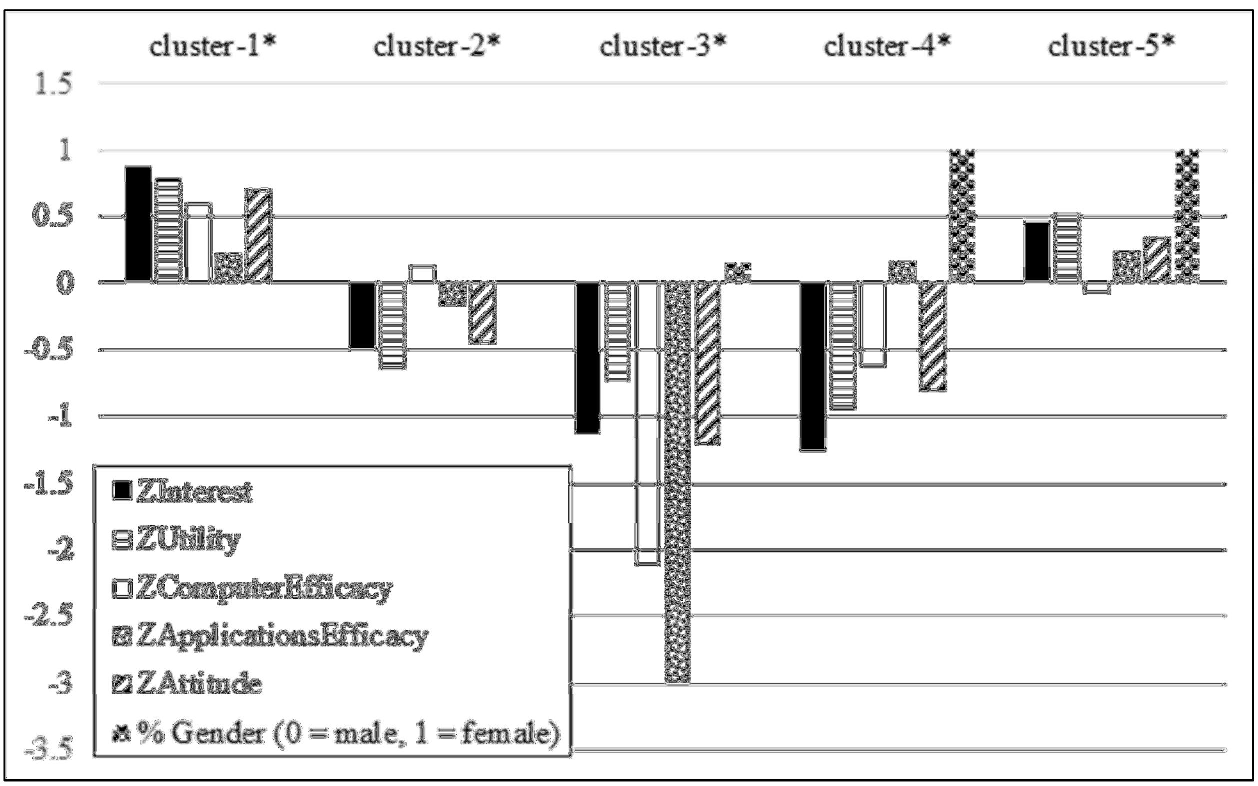

Figure 2. Student motivational profiles showing cluster means (Z-scores)

Table 1

Measures and their Sources

Dimension	# of items	Sources	Measurement
1. Task value perceptions (interest, importance, utility)	14	Individual interest scale (8 items, Linnenbrink-Garcia et al., 2010) Motivation scale (6 items, Ducan & McKeachie, 2005)	1 = Disagree strongly 7 = Agree strongly
2. Perceived task difficulty	1	Based on Eccles & Wigfield (1995)	
3. Computer self-efficacy	7	Computer self-efficacy scale (Marakas, Johnson, & Clay, 2007)	
4. Applications self-efficacy	5	Pisa 2009 ICT familiarity component (OECD, 2010)	
5. Attitudes towards computer use	4	Pisa 2009 ICT familiarity component (OECD, 2010)	
6. Change seeking	7	Change seeker index (CSI) short form (Steenkamp & Baumgartner, 1995)	
7. Influence on major choice	10	Downey (2011)	1 = Completely unimportant 5 = Very important

Table 2

Rotated Factor Scores for the Motivational Belief Scales

Scale Items	Interest	Utility	Computer Self-Efficacy	Application Self Efficacy	Attitude
ISInt6	**.837**	.351	.173	.051	.199
ISInt8	**.822**	.296	.203	.081	.225
ISInt5	**.812**	.410	.166	.029	.175
ISInt7	**.806**	.380	.171	.103	.246
ISInt4	**.718**	.280	.200	.003	.219
ClassPerc4	**.692**	.564	.120	.075	.163
ClassPerc6	**.689**	.541	.063	.010	.144
ClassPerc3	.209	**.868**	.049	.010	.116
ClassPerc5	.263	**.855**	.058	.065	.121
ClassPerc1	.214	**.737**	.214	.237	-.030
ClassPerc7	.443	**.721**	.071	.006	.067
ISInt1	.290	**.709**	.079	-.004	.259
ISInt3	.412	**.658**	.062	.140	.267
ISInt2	.362	**.568**	.058	.136	.065
GCSE4	.153	.101	**.870**	-.011	.114
GCSE6	.110	.185	**.853**	.058	.051
GCSE2	.229	.115	**.733**	.120	.114
GCSE5	-.058	.127	**.732**	.296	.113
GCSE3	.189	.037	**.677**	.394	.106
GCSE1	.126	-.056	**.646**	.159	.085
AppSE4	.000	.199	.094	**.776**	.036
AppSE5	.231	-.097	.230	**.706**	.034
AppSE3	-.098	.114	.127	**.685**	-.014
AppSE2	-.008	.289	.020	**.600**	.205
AppSE1	.130	-.133	.263	**.592**	.061
Attitude4	.061	.135	.108	.063	**.769**
Attitude2	.361	.137	.248	.135	**.745**
Attitude1	.301	.158	.039	.066	**.689**
Attitude3	.471	.159	.358	.077	**.648**
Cronbach's Alpha	α = .965	α = .918	α = .871	α = .715	α = .844
Mean	4.22	5.40	5.29	5.84	4.99
Std, Deviation	1.60	1.17	1.36	.96	1.31

Table 3

Rotated Factor Scores for the Salient Referents Scale

Scale Items	Non-Parental Referent	Parental Influence
Major Choice Influence: Other female working in the field	**.777**	.238
Major Choice Influence: High school counselor	**.776**	.163
Major Choice Influence: Friends or other students	**.754**	-.026
Major Choice Influence: High school teacher(s)	**.721**	.173
Major Choice Influence: College instructor	**.693**	.188
Major Choice Influence: Other male working in the field	**.660**	.261
Major Choice Influence: Both parents	.196	**.946**
Major Choice Influence: Male parent	.111	**.913**
Major Choice Influence: Female parent	.267	**.869**

Table 4.

Cluster Profiles (showing Z-scores for continuous variables)

	Cluster 1 n = 59 (34.3%)	Cluster 2 n = 44 (25.6%)	Cluster 3 n = 7 (4.1%)	Cluster 4 n = 23 (13.4%)	Cluster 5 n = 39 (22.7%)
Cluster variables					
ZInterest	0.869	-0.489	-1.118	-1.253	0.454
ZUtility	0.787	-0.637	-0.724	-0.943	0.522
ZComputerEfficacy	0.595	0.127	-2.11	-0.625	-0.069
ZApplicationsEfficacy	0.217	-0.154	-2.978	0.155	0.234
ZAttitude	0.692	-0.443	-1.202	-0.798	0.33
Gender (0 = male, 1 = female)	0.000	0.000	0.143	1.000	1.000
Other descriptive variables					
Z#_HighSchool-IS Courses	0.306	-0.057	-0.435	-0.349	-0.127
ZAge	0.013	-0.011	-0.029	-0.305	0.283
ZNonParentInfluenceMajorChoice	0.059	0.036	-0.162	-0.051	-0.125
ZParentInfluenceMajorChoice	-0.036	-0.028	0.103	0.163	-0.108
ZEasynessOfClassPerc	0.576	-0.356	-1.249	-0.685	0.125
ZChangeSeekingScore	0.175	-0.145	-0.859	-0.286	0.161
ITM_Major (0 = no, 1 = yes)	0.169	0.023	0.000	0.000	0.077
Number of students by major					
ACC (n = 22)	4 18.18%	4 18.18%	1 4.55 %	3 13.64%	10 45.45%
ECO (n = 9)	4 44.44%	1 11.11%	1 11.11%	1 11.11%	2 22.22%
ENTREPRENEUR (n = 17)	6 35.29%	5 29.41%	2 11.76%	3 17.65%	1 5.88%
FIN (n = 33)	10 30.30%	11 33.33%	2 6.06%	3 9.09%	7 21.21%
ITM (n = 14)	10 71.43%	1 7.14%	0 0.00%	0 0.00%	3 21.43%
MGT (n = 46)	18 39.13%	14 30.43%	1 2.17%	9 19.57%	4 8.70%
MKT (n = 31)	7 22.58%	8 25.81%	0 0.00%	4 12.90%	12 38.71%