Volume 12, No. 4
July 2014
ISSN: 1545-679X

INFORMATION SYSTEMS EDUCATION JOURNAL

In this issue:

The **Information Systems Education Journal** (ISEDJ) is a double-blind peer-reviewed academic journal published by **EDSIG**, the Education Special Interest Group of AITP, the Association of Information Technology Professionals (Chicago, Illinois). Publishing frequency is six times per year. The first year of publication is 2003.

ISEDJ is published online (http://isedjorg) in connection with ISECON, the Information Systems Education Conference, which is also double-blind peer reviewed. Our sister publication, the Proceedings of ISECON (http://isecon.org) features all papers, panels, workshops, and presentations from the conference.

The journal acceptance review process involves a minimum of three double-blind peer reviews, where both the reviewer is not aware of the identities of the authors and the authors are not aware of the identities of the reviewers. The initial reviews happen before the conference. At that point papers are divided into award papers (top 15%), other journal papers (top 30%), unsettled papers, and non-journal papers. The unsettled papers are subjected to a second round of blind peer review to establish whether they will be accepted to the journal or not. Those papers that are deemed of sufficient quality are accepted for publication in the ISEDJ journal. Currently the target acceptance rate for the journal is about 45%.

Information Systems Education Journal is pleased to be listed in the 1st Edition of Cabell's Directory of Publishing Opportunities in Educational Technology and Library Science, in both the electronic and printed editions. Questions should be addressed to the editor at editor@isedj.org or the publisher at publisher@isedj.org.

Investigating a 21st Century Paradox: As the Demand for Technology Jobs Increases Why Are Fewer Students Majoring in Information Systems?

Timothy Burns
tburns1@ramapo.edu

Yuan Gao
ygao@ramapo.edu

Cherie Sherman
csherman@ramapo.edu

Alexander Vengerov
abvenger@ramapo.edu

Stephen Klein
sklein@ramapo.edu

Anisfield School of Business,
Ramapo College of New Jersey
Mahwah, New Jersey 07430, USA

Abstract

This paper reports the results of a survey administered to 322 undergraduate business students enrolled in an introductory Information Systems course at a public liberal arts college located in the northeast US. The goal of this research was to learn, given the increased demand for technology oriented jobs, why fewer students are choosing the Information Systems (IS) major. The survey results indicate that lack of interest in IS or greater interest in another major are the primary reasons why students do not select IS as their major. Furthermore, even though students are knowledgeable about the career opportunities in the IS field, they simply do not find the IS field interesting enough to major in it.

Keywords: IS Education, IS Enrollment, IS/IT Major, IS/IT Career

1. INTRODUCTION

Each year there are several studies and news reports that list the "best jobs." The best jobs on these lists are usually selected based on a multitude of variables including employment opportunity, salary, work-life balance, and job security (US News and World Report 2013). This year, as well as for the last several years, technology oriented jobs such as Systems Analyst, Database Administrator, Software Developer, and Web Developer have consistently and routinely appeared near the top of these lists (CareerCast 2013, Forbes 2013, US News and World Report 2013). Projections from the U.S. Bureau of Labor Statistics (BLS) support these claims. For instance, the BLS projects a 22.1 percent employment growth for Systems Analysts jobs between 2010 and 2020 (BLS

2013). This is higher than the average of all other occupations.

Paradoxically, while there has been some improvement in recent years, in the 21st century, enrollment in the college majors that would prepare students for careers in technology oriented jobs is significantly less than it was at the turn of the century (National Science Board 2012, Zweben 2013). This phenomenon has not gone unnoticed. Information Systems (IS) and other technology oriented educators have been struggling to find the reasons why. Over the last several years there have been numerous studies and research papers reporting on this situation (Walstrom, Schambach, Jones, & Crampton 2008, Lenox, Jesse, & Woratscheck 2011).

Ramapo College, a public liberal arts college in northern New Jersey, has not been immune from this problem. Enrollment in the IS program (which is housed in the school of business) has shrunk over the last ten years. At the same time, enrollments in other business programs at the college, such as Accounting and Management, have expanded. This is especially surprising given the school's proximity to the high tech demand area of New York City.

This paper reports the results of a survey administered to 322 undergraduate business students enrolled in an introductory Information Systems course at Ramapo College. Participants were queried about their knowledge of career opportunities associated with each business discipline, their preferred job characteristics, job-related concerns, the most influential factors in selecting a major and a career, and their impression of the IT profession, among others. The goal of this research was to learn, given the increased demand for technology oriented jobs, why fewer students are choosing the Information Systems major.

2. LITERATURE REVIEW

Ever since enrollments in Information Systems (IS) and related majors began to decline in the early 21st Century, educators have sought to understand why and to reverse the decline. The well publicized growing need for IS professionals has fueled this effort rather than a self-serving desire by academics to maintain the status quo (Hecker 2005). Nevertheless, so far, research has not revealed a plan, which has been successfully applied to alter the enrollment trend (Saunders & Lockridge 2011). Walstrom and Schambach (2012) find that having students read an article about the job of a system requirements analyst improved students' perception of the IS field, which is evidence that a reversal may be possible. Accordingly, this literature review seeks to identify patterns in student preferences that will provide a blueprint for remediation. We will first review studies that identify the factors that influence student choice of major. Then we will focus on studies that explain why students do not choose IS.

At the time of the PC revolution of the early 1980s (Greene 2011), scholars were already seeking to identify the factors that influence choice of major field in the study of business. Hafer and Schank (1982) surveyed 942 business students and found, unsurprisingly, that career-related factors such as job security and financial reward were the primary influence. This has not changed much as a more recent study by Roach, McGaughey, and Downey (2009) found job availability and security to be paramount, which may reflect the current economic recession. After surveying students by major regarding 37 influences on choice of major (internal, external, and interpersonal), they found that although interest in the subject of the major was important, it played a secondary role. They also suggested that the impact of interpersonal influence may have been underestimated.

A related issue, which has yet to be explored thoroughly, is what is meant by "interest in the major." According to Rouibah (2012), Ferratt, Hall, Prasad, and Wynn (2009) surveyed 50 undergraduate students and found that job/career prospects, personal interest and ability (self-efficacy), and practical application of course work were the primary components. Roubiah notes that "practical application" is a broad descriptor and would include attributes such as problem solving, creativity, social interaction, helping others, utility to business, reputation, etc.

Other studies have been more finely tuned and focused on the differences between computer science (CS) and IS majors. For example, Roach et al. (2009) compared IS and CS majors at four US universities and found the most important influence for both majors was interest in technology and compensation. Notably, CS majors chose their major in high school or shortly thereafter while IS majors did not. Also, IS majors were more influenced by others, including instructors, parents, and friends, in making their choice. As expected, IS majors' choice was influenced by an interest in business organizations and interpersonal interaction while

CS majors were more interested in technology itself.

Another factor affecting major choice, specific to the information technology (IT) field, is the multiplicity of names for essentially the same course of study. Some examples are: computer information systems (CIS), management information systems (MIS), and ITM (information technology management). Tabatabaei and Tehrani (2010) found that there was no consistency in the naming of the major and proposed a study to determine whether there was a relationship between department name and enrollment. To date, a cause/effect relationship has yet to be determined although anecdotal evidence of the confusion is readily available by a cursory search of the Web.

Zhang (2007) applied the theory of reasoned actions to analyze the factors that influence students' selection of the IS major. According to this theoretical construct, students' perception of the likely outcomes of selecting the major, along with social pressure to do so, culminates in an intention to select it. In surveying a public urban university with a minority enrollment of 60%, Zhang discovered that interest in the field, availability of jobs, difficulty of the curriculum and influence of family and teachers were the important factors. He also particularly noted that female students did not feel encouraged by family, friends, advisors, and professors to the same extent male students did. Perceived difficulty and lack of encouragement from faculty were the key factors that worked against selection.

Building upon studies by Walstrom et al. (2008) and Hogan and Li (2011), Li and Thomson (2011) surveyed students in the business school of a medium-sized public university in the southeastern USA to determine why they had selected IS as a major. Again, career related factors and personal interest in the subject matter ranked highest. In addition, the image of the profession and the reputation of the program played a positive role in influencing students to select the major. The research also showed that business students in general regard the IS major positively which the authors opine indicates that other business majors are a fertile ground for IS recruitment. The authors also note that they were not able to identify information sources that students relied upon in selecting a major, which makes communication with potential majors problematic.

Based on qualitative one-on-one interviews across three western Pennsylvania higher education institutions, Lenox et al. (2011) found that IS students picked their major through self-collected inputs from the Internet. Sixty-six percent reported that their high school guidance counselor was not helpful in supplying information about computer-related disciplines. Interestingly, female students mention being influenced by male role models such as a father or brother to select the major.

Turning now to why students reject IS, Wong, Fiedler, and Lu (2007) surveyed undergraduate business students at one private and one public university to identify the differences between what the students were seeking in a career and what they believed the IS major would help them achieve. Students were asked how appealing a particular career outcome (career anchor) was to them and how likely each business major would be to lead to that outcome. MANOVA results revealed that the IS major was perceived to be unlikely to lead to career outcomes which matched students' needs and was perceived to be closest to the finance major in that regard. Marketing and management were seen as most different from IS and most likely to lead to competency in general management, servicing people, challenge, achievement of life style and entrepreneurial creativity. Management was seen as most likely to lead to security and stability in a career.

On the other hand, Walstrom et al. (2008) surveyed entry level business students and discovered that they were not majoring in IS because it was "not what I want to do" and "subject not of interest." Walstrom et al. noted that it is unwise for faculty to try to divine why students do not choose a major, citing a study by Noland, Case, Francisco, and Kelly (2003), which showed that reasons for accounting students avoiding accounting did not coincide with their professors' surmises. Walstrom et al. may not have identified all the sources that guide students in selecting a major because none of the sources they asked students about were identified as above average in importance. Also, the Walstrom et al. (2008) study drew only upon Midwestern students of traditional college-age. As many non-IS majors admitted to ignorance of the major, it is not clear that non-interest in the major was actually the reason why it was not chosen.

Hogan and Lei (2011) extended and validated the Walstrom et al. (2008) study in a different academic setting, a smaller state university with many non-traditional students. They found that career related issues were the most compelling influence upon major choice followed by student interest in the field of study. Notably, the IS majors were considerably older than the students in other majors. This prompted Hogan and Lei to suggest that recruitment focus on younger students. However, this may, in fact, indicate the need for the opposite approach because returning students are the most fertile demographic segment for recruitment.

Hogan and Lei (2011) also looked at student perceptions of IS programs. Students who major in accounting, marketing, and management perceived IS as likely to make them more competitive. Students reported that they learned about IS primarily from IS classes and IS faculty with fellow students a secondary source. Potentially an interesting first class in IS might convince students from these other majors to minor in IS.

Saunders and Lockridge (2011) surveyed IS graduates of a mid-sized Midwest university and discovered that students had a desire for a more career-oriented program of study with greater input from business leaders. The results also suggested that students were less interested in how the university experience improved personal traits such as critical thinking and more interested in improving job skills. The authors cite a relatively low post-graduate employment rate (60% within three months of graduation) as a possible influence upon the results. Nevertheless, 83% responded that their college education prepared them for their career and 78% said they would recommend the IS program.

Citing a study by Moore, Schoenecker, and Yager (2009), Lenox et al. (2011) note that at least some students continue to believe some popular fallacies about the IS field. These are that: 1) the job market for IS majors is poor, 2) IS majors primarily work with MS Office, and 3) IS jobs involve sitting at a computer all day. Overcoming these popular misconceptions promoted by the media will require ingenuity.

3. RESEARCH METHODOLOGY

This research was conducted using a "grounded theory" approach. Grounded theory was developed by the sociologists Barney Glaser and Anselm Strauss in the 1960's. In the grounded theory approach, conclusions are drawn and theories are produced by analyzing a body of data. In essence, the theories that are produced are "grounded" in the data (Glaser & Strauss 1967).

For this study, the process began by analyzing the current body of literature on the diminishing enrollments in IS programs. During this process a paper by Walstrom et al. (2008) was discovered that contained a survey instrument matching the requirements of this research. After permission was obtained from the authors, the survey instrument was reviewed and slightly modified. The survey includes mostly closed end questions (which are listed in the results section below) and a few open ended questions.

The survey was administered over a two year period, from the spring 2011 semester until the spring 2013 semester, to business students enrolled in a required introductory IS course. Students were given extra credit to participate in the study but were allowed to opt out for a replacement assignment. A total of 322 students chose to participate in the study.

4. RESULTS

1. What is your major?

Major	Number of Respondents	Percent
Accounting	62	19.3
Management	60	18.6
Marketing	57	17.7
Finance	44	13.7
Information Systems	23	7.1
International Business	13	4.0
Business/Business Administration	10	3.1
Economics	9	2.8
Business Dual Major/ Concentration/Minor	7	2.2
Business Undecided /Undeclared	4	1.2
Communications	5	1.6
Music Industry/ Music Production	3	0.9
Psychology	3	0.9
Computer Science	2	0.6
Engineering Physics	1	0.3
Law and Society	1	0.3
Social Sciences	1	0.3
Sociology	1	0.3
Other	14	4.3
Undecided	2	0.6
Total	322	100.0

Table 1. Respondents by Major

In this section, the data that was collected is summarized and presented as a series of tables. The survey questions are included to provide additional clarity.

2. At what point in your academic career did you decide on your major?

Time Decided Major	Number of Respondents	Percent
High School	104	32.3
Freshman	96	29.8
Sophomore	85	26.4
Junior	18	5.6
Senior	1	0.3
Other	14	4.3
Not yet/Not sure	4	1.2

Table 2. Time of Deciding a Major

3. In each of the following areas please identify how knowledgeable you are of the career opportunities associated with each discipline.

Area	Average Knowledge Level*	Lower Third Career Awareness**	
		Number of Respondents	Percent
Marketing	3.78	58	18%
Management	3.75	61	19%
Information Systems	3.63	50	16%
Accounting	3.57	70	22%
Finance	3.30	87	27%
Economics	3.09	102	32%
International Business	2.94	126	39%

*1 = Unaware; and 6 = Very Knowledgeable
** Lower Third = awareness level at 1 or 2

Table 3-1. Career Awareness Rating

Student's t-tests were performed on mean differences in career awareness for majors and non-majors.

Table 3-2 (Appendix) suggests there is a significant difference between the awareness of majors and non-majors regarding career opportunities in each discipline.

4. To what extent do you agree with the following?

I would like a job ...	Mean Agreement Score*
where creativity is encouraged	4.79
in a dynamic atmosphere	4.72
that allows independent work and autonomy	4.44
that involves a lot of verbal communication	4.41
that challenges me intellectually	4.38
that involves teamwork	4.26
that is routine and easy to master	3.84
where compensation is contingent on performance (e.g. commission)	3.73
that involves numbers and uses math based problem solving skills	3.71
that demands a heavy workload to demonstrate success	3.44

*1 = Strongly Disagree; and 6 = Strongly Agree

Table 4. Preferred Job Characteristics I

5. How important is each of the following to you?

I would like a job with ...	Mean Importance Score*
advancement opportunity (promotion, career ladder)	5.40
job security (little chance of lay-offs)	5.39
high long term earnings	5.33
plentiful supply of jobs (occupational growth)	5.15
flexibility of career options (career paths)	5.11
high initial earnings (starting pay)	4.82
high social status (prestige: proud to show your business card)	4.58
self-employment opportunities (private practice, consulting)	4.46
other. Please state what in the box below:	5.05**

*1 = Not Important; and 6 = Very Important

Table 5. Preferred Job Characteristics II

**One hundred seventy-two (172) respondents filled out the "other:" section. Frequently mentioned other job aspects as important include: enjoyment and happiness, environment and coworkers, benefits and bonuses, location, opportunity to travel, vacation time, and flexible hours.

Other comments include: pensions, nice boss, flexible with maternity leave, shorter hours, very little traveling, and free lunch, among others.

6. How concerned are you about each of the following?

How concerned are you about each of the following?	**Mean Concerned Score***
Jobs being outsourced overseas	4.11
Diminishing managerial levels in firms (a diminished career ladder)	4.03
Global competition	3.91
Jobs being replaced by technology	3.69
Needing to constantly learn new ways of doing business	3.49
Needing to constantly learn new technologies	3.21
Other. Please state what in the box below:	4.36**

* 1 = Not Concerned; and 6 = Very Concerned
Table 6. Job-Related Concerns

**One hundred seventy (170) respondents filled out the "other:" section. Over 60% of those expressed concern over the state of the economy and job availability.

Other individual concerns include: work requiring travel, increased demand/need for higher degrees, becoming CPA certified, competing with younger graduates, concerned about a flat tax, decay of newspapers, national debt, saving the world, etc.

7. To what extent do you agree with the following?

My impression of being an IT professional is that ...	**Mean Agreement Score***
IT is challenging work, especially in the first few years	4.52
IT professionals are dynamic advisors to business	4.42
IT /Computing Profession has more job growth than most other fields	4.27
IT professionals are trusted business advisors	4.23
IT is intellectually stimulating	4.20
IT requires math based problem solving skills	4.18
IT professionals have a positive image	4.16
in the IT field, Creativity is encouraged	4.14
being an IT professional requires long work hours	4.08
in the IT field, Interacting with other people is common	4.04
IT /Computing Profession has higher earnings than most other careers	4.04
IT involves a lot of verbal communication	3.84
in the IT field, Compensation is contingent on performance (e.g. bonus based)	3.73
many IT professionals become presidents or general managers of large businesses	3.29
being an IT professional is dull and boring	3.24
IT work is easy to master	2.77

*1= Strongly Disagree; and 6 = Strongly Agree
Table 7. Impression of an IT Professional

8. For each of the following, circle the importance of the item listed for why you selected your major.

Factor in Choice of Major	**Mean Importance Score***
Personal Interest in Subject Matter	5.06
Ease of Subject Matter – easy for me	4.00
Family Member (s)	3.87
Performance in University Subject Matter Courses	3.75
Reputation of Degree Program at University	3.74
Performance in High School Subject Matter Courses	3.51
Difficulty of Subject Matter – difficult for most people	3.46
Friend(s)	3.25
High School Teacher(s)	2.98
University Advisor(s)	2.68
University Career Services	2.64

Program(s)	
Counseling Center Career/Interest Tests/Assessments	2.63
High School Career/Interest Tests/Assessments	2.58
University Advisement Center	2.47
High School Guidance Counselor(s)	2.39
Other. Please state what in the box below	5.00**

*1 = Not Important; and 6 = Very Important

Table 8. Items of Importance in Selecting Major

**One hundred sixty-eight (168) respondents filled out the "other:" section. One single theme of these write-ins is the job market and job/internship availability as a factor in choice of major. A few outliers include television and movies, coaches, SAT performance, trial and error, hearsay, and that "dad is a businessman."

9. Which two of the items from question 8 were/are the most influential factors in the selection of your major?

Most Influential Factor 1	Number of Respondents	Percent
Personal Interest	158	49.1
Family Member(s)	66	20.5
Ease of Subject	21	6.5
Career Opportunities	16	5.0
Reputation of Degree Program	13	4.0
University Advisor	13	4.0
Friends	10	3.1
High School Teacher/GC	10	3.1
Performance in High School	3	0.9
Performance in University	3	0.9
Difficulty of Subject Matter	2	0.6
Others	7	2.2

Table 9-1. Most Influential Factor 1

Most Influential Factor 2	Number of Respondents	Percent
Personal Interest	55	17.1
Family Member(s)	53	16.5
Ease of Subject	39	12.1
High School Teacher/GC	26	8.1
Career Opportunities	26	8.1
Reputation of Degree Program	25	7.8
Performance in University	24	7.5
University Advisor	21	6.5
Friends	19	5.9
Performance in High School	16	5.0
Difficulty of Subject Matter	13	4.0
Others	5	1.6

Table 9-2. Most Influential Factor 2

Most influential factors 1 & 2	Number of Respondents	Percent
Personal Interest	213	33.1
Family Member(s)	119	18.5
Ease of Subject	60	9.3
Career Opportunities	42	6.5
Reputation of Degree Program	38	5.9
High School Teacher/GC	36	5.6
University Advisor	34	5.3
Friends	29	4.5
Performance in University	27	4.2
Performance in High School	19	3.0
Difficulty of Subject Matter	15	2.3
Others	12	1.9

Table 9-3. Most Influential Factors 1 and 2

10. How many times have you switched majors?

Number of Times Switched Major	Number of Respondents
0	197
1	94
2	22
3	9

Table 10. Number of Times Switched Major

Job opportunities and change of personal interest are two primary reasons students cited for changing a major.

11. To what extent were the following information sources important in choosing your major?

Information Source	Mean Importance*
Information on Internet/Web	3.86
Information on College/Department Website	3.55
Newspaper Articles	3.14
Brochures about the Major	3.09
Presentations by Faculty	3.02
Television or Movie portrayal of the occupation	2.94
Online Job Listing(s)	2.89
Presentations by Current Students	2.85
Job Listings in Classified Ads	2.83
Invited Speakers	2.82
Presentations by Alumni	2.69
Informational CDs or DVDs	2.30
Other. Please state what in the box below	3.31**

*1 = Not Important; and 6 = Very Important

Table 11. Importance of Information Source When Selecting Major

**Write-ins in the other box include family, friends, personal interest, professors, and media, etc.

12. If you are not a information systems major, what are two major reasons you are not?

The single theme which emerges for students not majoring in information systems is being uninterested in IS or liking another major better; a distant second reason is not being good with computer/IT or it seems hard/too technical.

Questions 13-15 omitted because of lack of pertinence to this paper.

16. What two things are most important to you in choosing a major?

The vast majority of the responses center around two themes: personal interest and career potential. A key-word search, which counts a response if it contains the word string but does not detect any misspelled words, shows 35.2% (227/644) of all responses contain the word interest, fun, passion, enjoy, like, love, happy or happiness, while 27.0% (174/644) of all responses contain the word career, money, job, financial, earning, pay or salary.

17. What two things are most important to you in choosing a career?

Again, the vast majority of the responses center around two themes: career potential and personal interest. A similar key-word search yields 43.9% (283/644) of responses containing the word career, money, job, financial, earning, pay or salary, while 27.5% (177/644) of responses contain the word interest, fun, passion, enjoy, like, love, happy or happiness.

The difference between responses to Questions 16 and 17 suggest students put more emphasis on career potential over personal interest when choosing a career as opposed to choosing a major.

18. For each of the majors listed below, please rate each major regarding your perceptions of the job characteristics associated with careers affiliated with that major.

Major	Job Availability	Pay and Benefits	Promotion Opportunities	Job Security	Mean
Accounting	4.13	4.14	3.66	3.84	3.94
Information Systems	4.16	3.87	3.81	3.74	3.90
Finance	3.80	4.18	3.92	3.52	3.86
Business Admin	3.63	3.84	3.86	3.53	3.72
Management	3.55	3.80	3.93	3.44	3.68
Marketing	3.58	3.56	3.79	3.29	3.56
Economics	3.37	3.66	3.45	3.31	3.45
Mean	3.75	3.86	3.77	3.52	

*1 = Negative; and 5 = Positive

Table 18. Perception of Job Characteristics of Corresponding Major

19. Use the same rating scale to show your perception of each degree area:

Area	Interesting Topics	Easy to do well	Faculty generally good	Faculty generally entertaining	Mean
Marketing	3.86	3.54	3.62	3.59	3.65
Business Admin	3.59	3.31	3.58	3.27	3.49
Information Systems	3.36	3.17	3.88	3.51	3.48
Management	3.68	3.36	3.56	3.33	3.48
Economics	3.26	3.00	3.39	3.09	3.19
Finance	3.16	2.83	3.38	3.00	3.09
Accounting	2.89	2.88	3.34	2.84	2.99
Mean	3.40	3.16	3.54	3.23	

*1 = Negative; and 5 = Positive

Table 19. Perception of Characteristics of Each Major

6. ANALYSIS OF RESULTS

In this section, an analysis is presented of the tables shown in the results section. Tables 1 and 2 show some basic information about the responders to the survey. Table 1 shows the breakdown by major of the respondents. The data shows that only 7.1% of the respondents are currently majoring in IS. Over 80% of the respondents are currently majoring in another business discipline and around 10% are majoring in a non-business discipline or undecided. Table 2 shows that over 75% of the respondents are sophomores or freshmen.

Tables 3-1 and 3-2 show how knowledgeable the respondents think they are of the career opportunities available in the various business disciplines. These tables are important to our study because they can show that students, even with knowledge of the career opportunities in IS, choose another major. Tables 3-1 and 3-2 appear to bear this out. Table 3-1 shows that the majority of respondents felt somewhat knowledgeable about IS career opportunities. In fact, IS career knowledge ranked third among the business disciplines, behind only Marketing and Management. Table 3-1 also shows that only 16% of the respondents reported that they were not knowledgeable about IS careers.

Table 3-2 shows more detail of the respondents' knowledge of career opportunities in the business disciplines by breaking the results down by majors and non-majors. This table clearly shows that respondents have much more knowledge of career opportunities in the discipline in which they are majoring. It should be noted, however, that even those respondents not majoring in IS still rated their knowledge of IS career opportunities as above average.

Tables 4, 5, and 6 show what kinds of job characteristics are important to students and what job related concerns students may have. Table 4 shows that respondents want a job where creativity is encouraged, the atmosphere is dynamic, independent work and autonomy is allowed, verbal communication is involved, there is intellectual challenge, and teamwork is integral. Table 5 shows that advancement opportunities, job security, high long term earnings, plentiful supply of jobs, flexibility of career options, and high initial earnings are also important to the respondents in their preferred job characteristics. Table 6 shows that students are most concerned about jobs being outsourced and diminishing career ladders.

Table 7 shows the respondents impression of being an IT professional. This is, again, important data to the study because it can help us analyze why students are not choosing the IT profession. Overall, the respondents appear to have a favorable impression of the IT profession. The number one impression is that IT is challenging work. Given the fact that table 4 showed that respondents wanted a job that challenged them intellectually, we would assume that this is a positive impression of IT. In fact, many of the impressions of IT listed near the top of table 7, such as job growth, intellectually stimulating, creativity, and a lot of verbal communication, correspond to the preferred job characteristics listed in tables 4 and 5. Some negative impressions of the IT profession include needing math skills, working long hours, and being dull and boring are also reflected in table 7. However, those characteristics show up near the bottom of table 7 and were, therefore, chosen less by the respondents.

Tables 8, 9-1, 9-2, and 9-3 show what factors influenced the respondents in choosing their major. All four of these tables corroborate each other in that all four show that "personal interest" is the number one influencer of how a student chooses their major. Table 8 has a slight discrepancy from the other three tables in that it shows "job market" as the second most often chosen influence, while the other tables list "family member" as the second biggest influence.

Table 10 shows that the vast majority of respondents have never switched majors or switched once. This could be a reflection of the demographical background of the respondents as over 75% were underclassmen. Table 11 shows information gathered via the Internet and college web sites were indicated by respondents as the most important information sources in choosing their major.

Question 12 from the survey (not represented by a table in the results section) asks for two reasons why the respondents are not an IS major. The single theme which emerges for students not majoring in information systems is being uninterested in IS or liking another major better; a distant second reason is not being good with computer/IT or it seems hard/too technical.

The results from questions 13 through 15 on the survey were omitted from this paper as the results were not pertinent to this discussion. The questions pertained to the respondents perceptions of the importance of various skill and knowledge areas.

Question 16 asked the respondents to identify the two things that were most important to them in choosing a major. The vast majority of the responses centered around two themes: personal interest and career potential. These findings support the results from the earlier questions (eight and nine) and reinforce the results of question 12 (that students do not major in IS because they are uninterested).

Question 17 asked the respondents to identify the two things that were most important to them in choosing a career. While the respondents identified the same two things for question 17 as they did for question 16, here an interesting result emerged. The students reversed the priority of the two responses. For question 17 students chose career potential as the most important thing in choosing a career with personal interest being second, while in question 16, they had chosen personal interest as the most important thing in choosing a major.

Tables 18 and 19 show some interesting results. Table 18 asked respondents to rate jobs within majors for several different job characteristics. In this table, IS is rated fairly high, finishing second in the business disciplines behind Accounting. However, when asked to rank the majors in Table 19, IS dropped to third among the business disciplines. This again supports the previous results whereby respondents rated the IS profession favorably but the IS major not as much.

7. DISCUSSION AND CONCLUSION

A key aspect of the study was the demographic makeup of the subjects. In particular, it should be noted that over 75% of the respondents were sophomores or freshmen. This fact could have far reaching implications for the entire study, but it has explicit effects on certain variables. For instance, the results from question two, which asks at what point the student chose a major (the majority had chosen in high school or as a freshman), and question ten, which asks how many times the student has switched majors (the majority of students in the study had never switched), would be impacted by the student's progress toward the degree, i.e., number of credits earned.

The overwhelming majority of underclassmen in the subject group could also offer an explanation for the disconnect between how a student chooses a major and how a student chooses a career. The results show that most students choose a major based on what they are interested in (Questions 8, 9, and 16) but choose a career based on career potential factors such as salary, career earnings, financial security, advancement opportunities, and job availability (Questions 4, 5, and 17). Perhaps because the subjects are still several years away from entering the job market, they can afford the luxury of choosing an interesting major that may not directly correlate to their long range career plans.

A further review of the results shows that students feel that they are just as knowledgeable about the career opportunities in IS as they are in the other business disciplines, in fact, they are less knowledgeable about the career opportunities in Accounting (Table 3-1). Students are most concerned about the economy, job availability, and jobs being outsourced overseas (Table 6). Students' impressions of being an IT professional (Table 7) show that they think that IT is challenging work and they do not think that IT work is easy to master. The IS major scores well when the students were asked about their perception of favorable job characteristics and their perception of favorable major characteristics (Tables 18 and 19).

When students were asked the key question, (Question 12, What are two reasons you are not an IS major?) point blank, they most often gave an answer that was consistent with why they chose their major. The number one reason that students do not choose IS as a major is because they are not interested or because they find another major more interesting. A distant second reason was that they feel IS is too hard. These results are consistent with the findings of previous studies (Walstrom et al. 2008).

The data seems to provide an answer for our research question as to why there is a paradox between the demand for high tech jobs and the lack of IS majors. Students want to major in something they perceive as interesting and, even though they are knowledgeable about the career opportunities in the IS field, they simply do not find the IS field interesting enough to major in it now.

Our future research will focus on how IS educators can get students to perceive the IS major as more interesting. Prior research (Lenox et al. 2011) has suggested that higher involvement with students while they are at the high school level may be a key factor in getting students interested in the IS field. We would like to determine if there are other factors that affect students' interest in the field.

8. REFERENCES

BLS (2013). U.S. Bureau of Labor Statistics. www.bls.gov. Accessed May 15, 2013.

CareerCast (2013). Jobs Rated 2013: Ranking 200 Jobs from Best To Worst. www.careercast.com/jobs-rated/best-worst-jobs-2013. Accessed June 2, 2013.

Downey, J., McGaughey, R., & Roach, D. (2009). MIS versus Computer Science: An Empirical Comparison of the Influences on the Students' Choice of Major. Journal of Information Systems Education, 20(3), 357-368.

Ferratt, T., Hall, S., Prasad, J., & Wynn, D. (2009). "Why Students Choose MIS: What Makes A Major-Job-Career in Management Information Systems Interesting?" Proceedings of the Special Interest Group on Management Information Systems 47th Annual Conference on Computer Personnel Research, New York, NY, 57-61.

Forbes Online (2013). The Top Jobs for 2013. www.forbes.com/sites/jacquelynsmith/2012/12/06/the-top-jobs-for-2013/2/. Accessed June 2, 2013.

Glaser, B. G. & Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*, Aldine Publishing Company, Chicago, IL.

Greene, J. (2011). The Computer Which Launched the PC Revolution. *CNET*, August 2011.

Hafer, J. & Schank, G. (1982). The Business Major: Making the Choice. *Journal of College Placement*, *4(*4), 47-49.

Hecker, D. E. (2005). Occupational Employment Projections to 2014. *Monthly Labor Review*, *128*(11), 70-101.

Hogan, P. & Lei, L. (2011). The Perceptions of Business Students Regarding Management Information Systems (MIS) Programs. *Journal of Technology Research*, *2*, 1-8.

Lenox, T., Jesse, G., & Woratscheck, C. (2011). Factors Influencing Students' Decision to Major in a Computer-Related Discipline. *Information Systems Education Journal*, 10(6), 63-71.

Li, L. & Thomson, N. (2011). "Why Business Students Select MIS as Their Major – An Empirical Examination," Proceedings of the Southern Association for Information Systems Conference, Atlanta, GA, 109-112.

Moore, J., Schoenecker, T. & Yager, S. (2009). "Harnessing IT Student Insight and Energy to Understand and Address the IT Enrollment Issue," Proceedings of the Special Interest Group on Management Information Systems 47th Annual Conference on Computer Personnel Research, NY, NY, 129-138.

National Science Board (2012). *Science and Engineering Indicators 2012*. Arlington VA: National Science Foundation (NSB 12-01).

Noland, T. Case, T., Francisco W., & Kelly J. (2003). "An Analysis of Academic Major Selection Factors: A Comparison of Information Systems and Accounting Students," Proceedings of the 18th Annual Conference of the International Academy for Information Management, Seattle Washington, November 12-14, Vol. 18, 150-156.

Roach, D., McGaughey, R., & Downey, J. (2009). Selecting a Business Major within the

College of Business. *Administrative Issues Journal: Education, Practice, Research*. *2*(1) 107-121.

Rouibah, K. (2012). Understanding Student Drivers and Obstacles toward MIS Major from the Perspective of an Arab Country: the Case of Kuwait. *Issues in Information Systems*, *13*(2), 58-71.

Saunders, G., & Lockridge, T. (2011). Declining MIS Enrollment: The Death of the MIS Degree? *Contemporary Issues in Education Research (CIER)*, *North America*, *4*(1), 15-26.

Tabatabaei, M. & Tehrani, M. (2010). Factors Impacting Enrollment in Information Systems Programs. *Issues in Information Systems*. *11*(1), 319-321.

U.S. News and World Report Online (2013). The 100 Best Jobs. money.usnews.com/ careers/best-jobs/rankings/the-100-best-jobs Accessed June 2, 2013.

Walstrom, K. & Schambach, T. (2012). Impacting Student Perceptions about Careers in Information Systems. *Journal of Information Technology Education: Research*. *11*, 235-248.

Walstrom, K., Schambach, T., Jones, K., & Crampton, W. (2008). Why Are Students Not Majoring in Information Systems? *Journal of Information Systems Education*, *19*(1), 43-54.

Wong, R., Fiedler, A. & Liu, C. (2007). Exploring the Motivation of Students in Choosing Information Systems as Their Major. *Issues in Information Systems*. *8*(1), 198-203.

Zhang, W. (2007). Why IS: Understanding Undergraduate Students' Intentions to Choose an Information Systems Major. *Journal of Information Systems Education*. *18(*4), 447-458.

Zweben, S. (2013). Computing Degree and Enrollment Trends, Computing Research Association. http://cra.org. Accessed June 14, 2013.

Appendix

Awareness of Career by Area		N	mean	d.f.	t	p
Accounting	Major	64	4.81	124	10.44	.000
	Non-major	258	3.26			
Economics	Major	9	4.33	8	2.82	.011
	Non-major	313	3.06			
Finance	Major	47	4.04	65	4.48	.000
	Non-major	275	3.17			
Information Systems	Major	25	4.80	28	5.13	.000
	Non-major	297	3.54			
International Business	Major	13	4.23	13	3.49	.002
	Non-major	309	2.89			
Management	Major	61	4.64	107	6.95	.000
	Non-major	261	3.54			
Marketing	Major	60	4.62	110	6.61	.000
	Non-major	262	3.58			

Table 3-2. Comparison of Career Awareness between Majors and Non-majors

Tool Choice for E-Learning: Task-Technology Fit through Media Synchronicity

Jun Sun
jsun@utpa.edu

Ying Wang
ywangz@utpa.edu

Department of Computer Information Systems & Quantitative Methods
University of Texas-Pan American
Edinburg, TX 78539, U.S.A.

Abstract

One major challenge in online education is how to select appropriate e-learning tools for different learning tasks. Based on the premise of Task-Technology Fit Theory, this study suggests that the effectiveness of student learning in online courses depends on the alignment between two. Furthermore, it conceptualizes the formation of such a fit through the lens of Media Synchronicity Theory: each type of learning task in the online environment requires a certain level of media synchronicity, and various e-learning tools enable different levels of media synchronicity. Their alignment forms along two dimensions of media synchronicity: the purpose dimension ranging from conveyance to convergence and the process dimension ranging from asynchronous to synchronous. The conceptualization leads to research hypotheses that posit the aligned relationships between learning tasks and e-learning tools in terms of purpose and process. The hypotheses were tested with the observations collected from an experiment, and the conjoint analysis results support that students do perceive and prefer the fit between learning tasks and e-learning tools along the two dimensions. The findings yield helpful insights on the best practices concerning the utilization of information technology for the enhancement of student learning outcomes in online course design.

Keywords: Online Course Design; E-learning Tool; Learning Task; Media Synchronicity; Conjoint Analysis.

1. INTRODUCTION

Today, computer-mediated communication technologies transform teaching and learning with their capacities to extend interactions over time and distance with the support of multiple media, such as text, graphic and voice (Garrison 2011). E-learning, a relatively new form of learning has been adopted by institutions at various levels, especially in higher education. In 2006, there were 3.5 million college students participating in on-line learning, and since then there has been a steady increase of more than 10 percent in on-line course enrollments per year in the United States, compared with an average of approximately two percent annual increase in overall enrollments (Allen & Seaman, 2007; Allen & Seaman, 2009; Allen & Seaman, 2003). Allen & Seaman (2009) found that that almost a quarter of all students in post-secondary education were taking purely online courses in 2008, and many more took some of their courses online. Therefore, e-learning is becoming a predominant form of education in the colleges and universities around the country.

Rogers (2000) described three levels of information technology adoption in learning. The first level is "personal productivity aids" based on the use of applications (e.g. word processing, spreadsheet) to perform the tasks more efficiently. This is the basic level of technology that has been adopted by most higher education institutions. The second level is "enrichment add-ins". At this level, CMC technologies such as email, video, websites and other multimedia tools, are added in to the traditional learning. However, course instructions remain the same with traditional lectures. At the third level, there is a "paradigm shift" (Massy & Zemsky, 1995) that requires instructors to redesign learning content and reconfigure teaching and learning tasks in order to take full advantage of new technology. Today, most higher education institutions have already reached the first and second level, and are striving for the third that leads to a fundamental change in the instructional paradigm (Rogers, 2000).

Unlike traditional pedagogy, educators need to rethink of instructional approaches to realize the potential of e-learning as an effective teaching method (Garrison, 2011; Rogers, 2000). Moreover, college students are different from children and teenagers: they are generally more self-motivated and capable of learning by themselves (Knowles, Holton, & Swanson, 2011). Thus, the education paradigm should shift from traditional lecturing to active learning in order to give students more control of how they learn (Smith, 2002). Instructors should rather facilitate student participation in learning tasks than just lecturing.

In today's higher education, most of the courses are still "teacher-centered": instructors give lectures, assign homework exercises and give tests. Learning in such traditional classroom settings largely relies on how instructors effectively communicate their knowledge to the student by improving the clarity of messages (Jonassen & Land, 2000). However, using the same instructional design in e-learning environment, such as reading and memorizing information online and then taking on-screen exams, will cause three significant problems (Privateer, 1999): 1) many contemporary ways of learning that are far more valuable and effective than traditional ways of learning are excluded; 2) important student needs that are related to their abilities to cope with the tasks in their future careers are mostly disregarded; and 3) colleges and universities fail to make necessary changes to adapt to the changes in the environment and narrow the gap between academia and industry.

Therefore, successful use of technology in online courses requires a shift from "teaching" to "learning", that is: instructional approach should switch from "teacher-centered" learning to "learner-centered" learning (Rogers, 2000). The students of new generation are learning in different ways from their predecessors, and in particular, college students who take online courses desire more active learning based on the learner-centered approach than those who take in-classroom courses (Anson, 1999; McCormick, 1999; Rogers, 2000). This study tries to address the issue of how to promote the effectiveness of online education with appropriate use of information technology.

2. LITERATURE REVIEW

A report from the Columbia University found that students who participated in online courses had lower success rates than those in face-to-face courses: on average, online course completion rates were eight percent lower than traditional course completion rates (Xu & Jaggars, 2011). The top reason for dropping online courses is the lack of time due to personal issues such as family, health, jobs and child care (Xu & Jaggars, 2011). However, Mason (2006) found that students often use the lack of time as a convenient excuse for not engaging in learning. On the other hand, the root of the problem may be in the fact that many online courses lack the means to motivate students and allow them to learn effectively.

The goal of the higher education is to prepare students for their future career in the real world. Rather than traditional lecturing, learner-centered courses engage students in hand-on experiences, problem solving, collaborating with classmates and instructors, and even contributing course content (Bale & Dudney, 2000; Cooper & Henschke, 2005). The advances in information technology great facilitate such active learning. Students can easily establish online learning communities to share experience and knowledge with each other for team problem solving, collaborative essay writing, discussions, group projects, and so on (Bonk, Wisher & Lee, 1998). Through the participation in these learning tasks, students can develop their own skills to handle real-world problems that often require compromising and improvising to accommodate tradeoffs and limitations (Simonson et al., 2000).

Since 1990s, the American Psychological Association (APA) has advocated the learner-centered approach that emphasizes the reflective and collaborative aspects of learning and the active role that students can play in such efforts. APA announced a set of 14 Learner-Centered Psychological Principles that address four dimensions of factors: cognitive and metacognitive factors, motivational and affective factors, developmental and social factors, and individual difference (APA, 1997). The learner-centered approach in online environment needs to encourage students to actively participate in learning tasks, promote in-depth discussions, develop deep and comprehensive understanding of teaching materials, and connect learning to work experiences and requirements (Davies & Graff, 2005; Karayan & Crowe, 1997; Smith & Hardaker, 2000).

The ultimate success of online courses, therefore, largely relies on the establishment of learner-centered and collaborative learning environment. The emergence of electronic learning (e-learning) tools, such as Discussion Board, Wiki, and Blog, provide much needed technical support for this active learning approach (Dron, 2003; Glogoff, 2005; Parker & Chao, 2007; Tosh & Werdmuller, 2004; Weller, Pegler & Mason, 2005). For example, Discussion Board provides students a platform to exchange ideas with and give feedbacks to each other on a certain topic. An instructor plays the role of moderator by outlining the theme and guiding the discussion.

Because e-learning tools have great potential to support active learning, there is a need for the discussion of best practices concerning their use in online course development. Prior research has established some understanding of the roles that various e-learning tools play in online education. For instance, Hrastinski (2008) found that asynchronous e-learning tools are more appropriate for achieving content-related objectives that often require students to spend time digesting course materials, whereas synchronous e-learning tools are better suited for team-based learning such as group task planning and execution in which real-time responses help students focus on their endeavor.

However, few researchers have examined student preferences toward different e-learning tools for different learning tasks. The main obstacle is the lack of appropriate theoretical frameworks for such empirical studies. The lack of theories and observations lead to the absence of guideline that educators can follow to incorporate e-learning tools in the development of online courses. At the current stage, many instructors may select the e-learning tools that they are familiar with. If students do not like to use a given tool for a certain task, they may get frustrated and complain to each other. This distracts their attentions and compromises the effectiveness of online learning.

3. RESEARCH MODEL AND HYPOTHESES

The primary objective of this study is to develop and test a research model to answer the question of how to select appropriate e-learning tools for different learning tasks. An appropriate theoretical foundation is the Task-Technology Fit model that suggests the alignment between task characteristics and technology characteristics leads to enhancement of task performance and technology utilization (Goodhue & Thompson, 1995). However, the model does not elaborate on how the alignment is established; rather, it assesses the perceived fit with users' subjective responses in empirical studies.

In the context of the alignment between e-learning tools and learning tasks, the conceptualization of fit needs to be based on the understanding of the roles that e-learning tools play in student learning tasks. The emerging e-learning tools promote the participation of students in active learning by allowing them to interact with instructors and collaborate with each other. In this sense, the e-learning tools are that electronic media that facilitate and support such computer-mediated communications. Thus, the characteristics of e-learning tools can be examined with an established theory on electronic media.

One theory that focuses on the characteristics of electronic media is the Media Synchronicity Theory (Dennis, Fuller & Valacich, 2008; Dennis & Kinney, 1998). It characterizes electronic media with the concept of media synchronicity according to their transmission capabilities and processing capabilities (Dennis et al., 2008). Similarly, computer-mediated communications are usually classified into two types: synchronous versus asynchronous (Turoff, 1989). Distributing at different levels of synchronicity, therefore, the characteristics of e-learning tools as electronic media and the characteristics of learning tasks as computer-mediated communications are comparable.

In addition to the process that can be either synchronous or asynchronous, researchers suggest that computer-mediated communications vary in their purposes (Thurlow, Lengel & Tomic, 2004). There are generally two communication purposes for which electronic media are used for: conveyance that refers to "the discussion of preprocessed information about each individual's interpretation of a situation, not the raw information itself" and convergence that refers to "the transmission of a diversity of new information— as much new, relevant information as needed—to enable the receiver to create and revise a mental model of the situation" (Dennis et al., 2008; Dennis & Kinney, 1998). Media of relatively low level of synchronicity generally support communications for conveyance purposes, but media of relatively high level of synchronicity generally support communications for convergence purposes (Dennis et al., 2008).

The degrees of alignment between e-learning tools and learning tasks vary along these dimensions. When a tool and a task match with each other along both dimensions, there is a task-technology fit. On the other hand, if they mismatch with each other along either dimension, there is a lack of fit. An alignment between a tool and a task leads to the enhancement of technology usage and learning outcome, but a misalignment discourages students from participation and weakens their performance.

Therefore, the characteristics of e-learning tools and the characteristics of learning tasks are comparable along the process and purpose dimensions. The research model shown in Figure 1 depicts that the fit between learning tasks and e-learning tools is established through media synchronicity. In specific, a learning task requires a certain level of synchronicity in terms of the process and purpose of computer-mediated communications, which leads to user preference of an e-learning tool that enables such a level of synchronicity. That is, students would like to use a tool for a task if they perceive a fit between two along both the process and purpose dimensions.

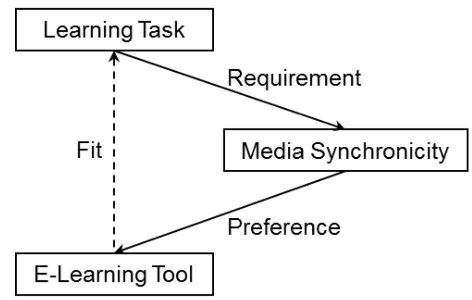

Figure 1. Research model

To validate the proposition that students do prefer the alignment between learning tasks and e-learning tools along the two dimensions of media synchronicity, it is necessary to develop relevant hypotheses that can be tested with empirical observations. In the research hypotheses, both process and purpose dimensions are treated as dichotomous variables that take two values: 0 indicates the relatively low level of synchronicity and 1 indicates the relatively high level of synchronicity. For the purpose variable, convergence implies a higher level of media synchronicity than conveyance, and thus the former is coded as 1 and latter is coded as 0. On the other hand, synchronous process suggests a higher level of media synchronicity than asynchronous process, and in the same way, the former is coded as 1 and latter is coded as 0.

In each hypothesis, the independent variables concern the characteristics of a certain type of learning tasks in terms of the purpose and process required in computer mediated communications, and the dependent variables concern the preferred characteristics of e-learning tools in terms of the purpose and process supported by the media. In other words, the characteristics of a learning task influence student preference toward e-learning tools along the two dimensions. A learning task is expected to have a positive (or a negative) effect on a variable if it requires a relatively high (or low) level of synchronicity along that dimension. For example, if a task requires asynchronous computer-mediated communication, its effect on the process variable of user preference toward e-learning tools is likely to be negative. The discussions lead to the following four hypotheses:

H1: A learning task of asynchronous process for conveyance purpose has negative effects on both the process and purpose variables of e-learning tool preference.

H2: A learning tasks of synchronous process for conveyance purpose has a positive effect on the process variable but a negative effect on the purpose variable of e-learning tool preference.

H3: A learning tasks of asynchronous process for convergence purpose has a negative effect on the process variable but a positive effect on the purpose variable of e-learning tool preference.

H4: A learning task of asynchronous process for convergence purpose has positive effects on both process and purpose variables of e-learning tool preference.

Based on the hypothesized relationships, Table 1 gives the likely task-technology fit between common e-learning tools and typical learning tasks. Blog stands for "Web Log" and it allows each student to *share* their thoughts, experiences and ideas with others through a personal space, and thus it is probably preferred for a learning task that requires the communications of asynchronous process for conveyance purpose. Discussion Board allows students to *explore* a certain topic by posting comments and responses without the necessity to reach an agreement. Thus, it is probably preferred for a learning task that requires the communications of synchronous process for conveyance purpose. Wiki stands for "what I know is" and it allows students to *compile* an essay on a certain topic in turn. Thus, it is probably preferred for a learning task that requires the communications of asynchronous process for convergence purpose. Web conference applications (e.g. Wimba®) allow multiple users to *coordinate* teamwork (e.g. presentation) on a real-time basis. Thus, it is probably preferred for a learning task that requires the communications of synchronous process for convergence purpose.

	Process	
Purpose	Asynchronous	Synchronous
Conveyance	Sharing: Blog	Exploring: Discussion Board
Convergence	Compiling: Wiki	Coordinating: Web Conference

Table 1. Task-Technology Fit Examples

To test the research hypotheses, observations need to be gathered from a laboratory experiment that simulates different learning tasks to students and asks for their preferences toward different e-learning tools. If e-learning tool preferences are consistent with what are expected from the requirement of task characteristics, there is supporting evidence of the research hypotheses. The next section discusses the methodology.

4. METHODOLOGY

Target Population

The purpose of this study is to find out how to choose different e-learning tools for different learning tasks for the design and development of online courses in higher education. The selection of target population needs to be based on who are the true stakeholders in the use of such tools. Unlike traditional teaching tools (e.g. PowerPoint), the emerging new e-learning tools aim to facilitate student participation and active learning. Students are the actual user of the e-learning tools, rather than instructors who are supposed to play the role of facilitators and moderators (Bonk & Kim, 2004; Maor, 2003).

In designing and developing an online course, therefore, an instructors need to select an e-learning tool that is the most appropriate for a learning task to enhance student learning experiences. The leaner-centered approach gives students the final say for e-learning tool choice: if an instructor selects an inappropriate e-learning tool for a learning task, students may complain and ask for the change. The target population of this study, therefore, comprises college students who are the potential users of e-learning tools.

Experiment Design

Testing the aforementioned research hypotheses requires an experiment in which participants are exposed to different learning task treatments. Because the tasks vary along two dimensions and each dimension has two levels, there will be altogether four treatments from a 2x2 factorial design. One factor is process that has asynchronous and synchronous levels, and the other factor is purpose that has conveyance and convergence levels. Table 2 gives the factorial design.

	Process	Purpose
Task 1 (H1)	Asynchronous	Conveyance
Task 2 (H2)	Synchronous	Conveyance
Task 3 (H3)	Asynchronous	Convergence
Task 4 (H4)	Synchronous	Convergence

Table 2. Factorial Design

At the beginning of the experiment, participants watched a demonstration of different e-learning tools, including a Blog article, a Wiki entry, a Discussion Board thread and a video of how to use Wimba. Then they indicated their preferences among the e-learning tools by ranking them for each of learning tasks. To find out user background information, they also answered a few questions regarding their gender, the access to computer and Internet, online course experience, Blackboard usage and computer anxiety. The total process took about 15-20 minutes.

Analyses

The main analytical technique applied is conjoint analysis. Conjoint analysis is a statistical technique often used in market research to find out people's preferences towards different features of a product or service (Green & Srinivasan, 1978). Though not many IT researchers have applied conjoint analysis in their studies, there have been some cross-disciplinary studies such as electronic commerce that employ the technique (e.g. Schaupp & Bélanger, 2005).

Compared with typical survey studies, conjoint analysis does not require the collection of perceptional and attitudinal responses from participants but rather their multi-attributed preferences towards different options in form of rankings or choices (Srinivasan, 1988). The technique is appropriate for this study as it is less subjective but more direct-to-the-point to examine user choice of e-learning tools for different learning tasks.

There are three steps of conducting conjoint analysis: 1) orthogonal design that generates different options based on the combinations of several attributes; 2) preference elicitation that collects the preferences of participants towards the options; and 3) data analysis that analyzes the user preferences in accordance to the orthogonal design (Green & Srinivasan, 1990). In this study, there are two attributes of e-learning tools, process and purpose, and each has two levels. Thus, e-learning tools can be categorized based on the combinations: Blog that facilitates asynchronous process for conveyance purpose; Discussion Board that facilitates synchronous process for conveyance purpose; Wiki that facilitates asynchronous process for convergence purpose; and Wimba that facilitates synchronous process for convergence purpose.

Most of the studies that conduct conjoint analysis are exploratory in nature in that they want to find out how important each attribute is to subjects. This study applies the technique in a confirmatory manner to test research hypotheses. In addition to different technological options, the participants of this study are exposed to different tasks. The characteristics of tasks and technologies vary along the same dimensions, and it is expected that user preferences of e-learning tools be consistent with the configuration of learning tasks. Thus, multiple rounds of conjoint analysis are to be conducted to test the hypothesized fits between e-learning tools and learning tasks.

The tool used for conjoint analysis in this study is SPSS. It provides the module for generating the orthogonal design file, spread sheet for compiling data file of user preferences, and conjoint syntax for analyzing data. The output comprises the estimate of each attribute and its standard error, relative importance scores of attributes, as well as the correlation between the predicted and actual user preferences.

Sample Size

According to Johnson and Orme (2003), the minimal sample size for choice-based conjoint analysis can be calculated with formula [1]. The ratings-based conjoint analysis that is this study conducts generally requires smaller sample size as it is a more efficient way to learn about preferences than choice-based conjoint analysis (Orme, 2006). Generally speaking, larger sample size enhances the reliability of standard error estimates.

$$n = 500*c/(t*a) \quad [1]$$

Where:
n = the number of respondents;
c = the largest number of levels for any one attribute;
t = the number of tasks;
a = the number of alternatives per task.

In this study, there are two levels for each of the computer-mediated communication attributes, process and purpose. There are altogether four learning tasks, and for each there are four e-learning tools that subjects can choose. Thus, *c*, *t* and *a* are equal to 2, 4 and 4 respectively. Formula [2] gives the calculation of sample size.

$$n = 500*c/(t*a) = 500*2/(4*4) = 62.5 \qquad [2]$$

The actual sample size used in this study will be a little bit larger than what is required to accommodate possible non-responses. The number of participants in this study, therefore, is in the range between 65 and 75. On one hand, if the sample size is too small, the study may lack the sufficient statistical power to detect significant relationships; on the other hand, if the sample size is too large, the analysis may be so powerful that it picks up errors and nuisances that are not practically significant at all (Kerlinger, 1986).

5. RESULTS

The participants of this study were solicited on a voluntary basis from three undergraduate classes in a southwest university. There were altogether 72 participants, and two of them did not give the rankings of all options, but just checked the ones that they preferred. Thus, there are 70 usable responses, and the response rate is 97%. Among the participants, 59.72% are males and 40.28% are females.

Researchers found that gender difference may be salient in information systems user behavior related to e-learning (Ong et al., 2006). If gender difference is salient in this study, it means that it might be necessary to customize the e-learning tool choice for males and females separately. Table 3 gives user profiles for the overall sample as well as for each gender. Almost all students had the access to computers and Internet, and few had computer anxiety as the average score is close to 1, the smallest value of the range between 1 and 5. Over 70% of the students had taken online courses before and close to 90% had used Blackboard in online and hybrid courses. The average frequency of using Blackboard is about 6 times a week. Close to 90% of the students have part-time or full-time work experiences.

	Overall	Female	Male
Having PC	97%	100%	95%
Internet Access	94%	100%	91%
Used Blackboard	87%	86%	88%
Online courses	73%	68%	76%
Work experiences	89%	86%	91%
Blackboard/week	6.24	5.54	6.71
Computer Anxiety	1.31	1.30	1.32

Table 3: User Profiles and Gender Differences

Across genders, there were some differences in the profiles: females in the sample had slightly higher rate of computer and Internet access but slightly lower rate of blackboard usage and online course taking than males. The differences were relatively small, indicating that the gender differences are not likely to play a significant role in the use of e-learning tools.

Table 4 gives the parameter estimates of the conjoint analysis for each learning task. Task 1 yielded significantly negative influence on both Process and Purpose variables of e-learning tool preference. This provides full support for Hypothesis One (H1). Task 2's effect on Process was positive and marginally significant and its effect on Purpose was negative but not significant. The directions of effects were consistent with what are hypothesized but the strengths of effects were not as strong as expected. Thus, this result provides partial support for Hypothesis Two (H2). In contrast, Task 3's effect on Purpose was positive and marginally significant and its effect on Process was negative but not significant. Similar to the previous case, the result provides partial support for Hypothesis Three (H3). Finally, Task 4 had significantly positive impact on both Process and Purpose variables, which provides full support for Hypothesis Four (H4).

H	Process	Purpose	RI	*r*
1	-1.04(.34)**	-1.39(.34)**	.44/.56	.98**
2	1.27(.87)*	-.57(.87)	.63/.37	.85*
3	-.36(1.03)	1.36(1.03)*	.25/.75	.81*
4	1.36(.33)**	1.17(.33)**	.53/.47	.98**

Table 4: Parameter Estimates

Note: Standard errors given in parentheses beside slope estimates. RI: Relative Importance; *r*: correlation between observed and estimated preferences. *: p-value<0.1; **: p-value<0.01.

SPSS also gives the importance scores of the attributes. In this study, there are two variables and the score indicates the percentage of total variation explained by each variable. Thus, the importance scores reflect the actual task requirement on synchronicity along the two dimensions. For Task 1, users believed that the purpose that e-learning tools support was a little bit more important than the process they facilitate (approximately 5:4). Task 1 asked students to write down and share their ideas, thoughts and experiences with others. The communication process involved was very basic (i.e. writing), and the purpose of sharing was also quite simple. For Task 4, users regarded the process that e-learning tools facilitated a little bit more important than the purpose they supported (approximately 7:6). Task 4 asked students to work on a group project deliverable. The communication process involved real-time interactions and the purpose was to reach a consensus. Both tasks imposed equivalent levels of requirement on Process and Purpose, leading to similar importance scores.

For Task 2, users emphasized the communication process that e-learning tools facilitated then the purpose that they supported (approximately 5:3). Task 2 asked students to explore a research topic with others. It required intensive communication process in form of discussions but participants do not need to negotiate and compromise to reach agreements. For Task 3, on the other hand, users emphasized the purpose that e-learning tools supported much then the communication process that they facilitated (approximately 3:1). Task 3 asked students to develop a systematic study on a subject in a team. It required participants to work on individual basis but obtain a final product that was acceptable to all. Both tasks had unbalanced requirements on Process and Purpose, leading to different importance scores.

Finally, SPSS gave the correlation coefficients between predicted and actual preferences. The coefficient was highly significant for Tasks 1 and 4, but marginally significant for Tasks 2 and 3. For both Process and Purpose variables, Task 1 had low values and Task 4 had high values, resulting in clearly low and high requirements on media synchronicity. In comparison, the requirements of Tasks 2 and 3 were mixed as they had low value for one variable but high value for the other. This also explained why both variables were highly significant for Tasks 1 and 4, but only one variable was marginally significant and the other was insignificant for Tasks 2 and 3.

6. CONCLUSION AND IMPLICATIONS

This study examines an important issue in online course design and implementation: how to choose different e-learning tools for different learning tasks. With the emergence of numerous e-learning tools, instructors face the challenge of aligning technology and task in online course development, especially when they do not know which tools the students would like to use for a certain type of learning tasks. As an effort, this study develops a research model of task-technology fit through media synchronicity based on the premises of both Task-Technology Fit Theory and Media Synchronicity Theory. To test the research hypotheses derived from the model, this study conducted a conjoint analysis using student rankings of various e-learning tool options for different learning tasks, and the results provide fully supporting evidence for two hypotheses and partially supporting evidence for the other two.

This study yields some important theoretical and practical implications. Theoretically speaking, it integrates the Task-Technology Fit Theory and Media Synchrony Theory into the research model of task-technology fit through media synchronicity. Previous studies of task-technology fit typically assess the perceived fit between information technologies and tasks without addressing the intermediary of the alignment. This study posits that media synchronicity mediates the relationship between task and technology. That is, a learning task imposes certain requirement on the synchronicity level of the computer-mediated communication, which leads to user preference of an e-learning tool that facilitates the communication with needed media synchronicity capabilities. In addition, this study identifies the process and purpose dimensions of media synchronicity and uses both to categorize e-learning tools as well as learning tasks.

The inclusion of media synchronicity as the intermediary of task-technology fit allows the use of conjoint analysis to study fit. Prior research on task-technology fit focuses on user perception of fit. This perceptional fit is indirect and subjective. Rather, this study examines the fit based on student rankings of different e-learning tools for different learning tasks. Through multiple rounds of conjoint analyses, task-technology fit can be assessed in a more direct and objective manner. The methodology employed in this study, therefore, point out a new direction of studying task-technology fit.

For practitioners, the findings of this study provide a guideline for making good choice of e-learning tools for different learning tasks in the development of online courses. Different e-learning tools facilitate and support computer-mediated communications involved in active learning in different ways. Thus, the choice of appropriate e-learning tools for a variety of learning tasks will enhance the learning experiences of students significantly compared with traditional in-classroom lecturing. On the other hand, inappropriate e-learning tool choices may either limit student participation or distract student attention.

For example, if a learning task is designed to let student practice coordination and negotiation in teamwork but the learning tool selected support conveyance purpose, the students are not likely to reach an agreement using this tool. Student participation is limited in this sense as the tool does not promote coordination and negotiation. On the other hand, if a learning task emphasizes independent thinking, it only requires asynchronous communication. The use of an e-learning tool that facilitates synchronous communication may distract student attention. Therefore it is not necessary that that the higher synchronicity the better: the choice of e-learning tools needs to match the requirements of learning tasks.

Despite the contributions, this study has several limitations. First of all, this study includes Blog, Wiki, Discussion Board, and Wimba as the e-learning tools. There are many other e-learning tools in addition to them that instructors use for online and hybrid courses. The four tools are included because they can be categorized into the four quadrants along the process and purpose dimensions. The objective of this study is to test the research model of task-technology fit through media synchronicity, and the inclusion of typical e-learning tools that are distinct from each other enhance the statistical power for testing the research hypotheses. Nevertheless, the exclusion of other e-learning tools weakens the generalizability of the findings.

Another limitation of this study is related to binary coding of the process and purpose variables. Currently, the process variable has two levels: synchronous versus asynchronous. Few electronic media facilitate completely synchronous or asynchronous communications. For instance, this study categorizes Wiki as a media that facilitate asynchronous communications. Yet it is arguable that compared with Blog, Wiki is more synchronous as participants can take turns working on the same piece of work. In the same way, it may be too simplistic to categorize e-learning tools that support communications for either conveyance or convergence purposes respectively. Thus, many e-learning tools vary in degrees of both the process and purpose dimensions and they cannot be easily divided into just a few groups.

In future studies, more e-learning tools need to be included and their attributed need to be characterized with a more refined scale. For instance, the Process variable may have four levels: mostly asynchronous, somewhat asynchronous, somewhat synchronous, and mostly synchronous. In the same way, the Purpose variable may have four levels from mostly conveyance to mostly convergence. This will enrich the research hypotheses proposed in this study and make them more realistic. In addition, the results will provide practitioners such as instructors and IT administrators more guidance on how to choose among the numerous options of e-learning tools for different learning tasks.

7. ACKNOWLEDGEMENT

This study was partially supported by Academic Partnerships with a research grant awarded to the first author.

8. REFERENCES

Allen, E., and Seaman, J. (2007). *Online nation: Five years of growth in online learning*. Sloan Consortium. Retrieved on October 15 2012 from http://sloanconsortium.org/publications/survey/pdf/online_nation.pdf.

Allen, I., and Seaman, J. (2009). *Staying the course: Online education in the United States, 2008*. Sloan Consortium. Retrieved on December 2, 2012 from http://sloanconsortium.org/publications/survey/staying_course.

Allen, I. E., and Seaman, J. (2003). *Sizing the Opportunity: The Quality and Extent of Online Education in the United States, 2002 and 2003*. Sloan Consortium. Retrieved on November 18, 2012 from http://sloanconsortium.org/publications/survey/sizing_the_opportunity2003.

Anson, C. M. (1999). Distant voices: Teaching and writing in a culture of technology. *College English, 61* (3), 261-280.

APA (1997). *Learner-centered psychological principles: A framework for school reform & redesign*. Washington, DC: American Psychological Association. Retrieved on May 2, 2013 from http://www.cdl.org/resource-library/articles/learner_centered.php.

Bale, J. M., and Dudney, D. (2000). Teaching generation X: Do andragogical learning principles apply to undergraduate finance education. *Financial Practice and Education, 10*, 216-227.

Bonk, C. J., and Kim, K. A. (1998). Extending sociocultural theory to adult learning. In M. C. Smith and T. Pourchot (eds.) *Adult learning and development: Perspectives from educational psychology* (pp. 67-88), Mahwah, NJ: Lawrence Erlbaum Associates.

Bonk, C. J., Wisher, R. A., and Lee, J. Y. (2004). Moderating learner-centered e-learning: Problems and solutions, benefits and implications. In T. S. Roberts (ed.) *Online collaborative learning: Theory and practice* (pp. 54-85). Hershey, PA: Information Science Publishing.

Cooper, M., and Henschke, I. (2005). Additional thinking about andragogy: The international foundation for its research, theory and practice linkage in adult education and human resource development an update. In the *Proceedings of the Commission on International Adult Education (CIAE) Pre-Conference of the American Association for Adult and Continuing Education (MACE)*. St. Louis, MO: University of Missouri 2005.

Davies, J., and Graff, M. (2005). Performance in e-learning: online participation and student grades. *British Journal of Educational Technology, 36* (4), 657-663.

Dennis, A. R., Fuller, R. M., and Valacich, J. S. (2008). Media, tasks, and communication processes: A theory of media synchronicity. *MIS Quarterly, 32* (3), 575-600.

Dennis, A. R., and Kinney, S. T. (1998). Testing media richness theory in the new media: The effects of cues, feedback, and task equivocality. *Information Systems Research, 9* (3), 256-274.

Dron, J. (2003). The blog and the borg: A collective approach to e-learning. In A. Rossett (ed.) the *Proceedings of E-learn 2003: World Conference on E-Learning in Corporate, Government, Healthcare and Higher Education* (Nov. 2003, Phoenix), pp. 440-443.

Garrison, D. R. (2011). *E-Learning in the 21st Century: A Framework for Research and Practice, (2 ed.)*. New York, NY: Routledge.

Glogoff, S. (2005). Instructional blogging: Promoting interactivity, student-centered learning, and peer input. *Journal of Online Education, 1*(5). Retrieved on May 1, 2013 from http://www.innovateonline.info/pdf/vol1_issue5/Instructional_Blogging-__Promoting_Interactivity,_Student-Centered_Learning,_and_Peer_Input.pdf.

Goodhue, D. L., and Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly, 19* (2), 213-236.

Green, P. E., and Srinivasan, V. (1978). Conjoint analysis in consumer research: issues and outlook. *Journal of consumer research, 5* (2), 103-123.

Green, P. E., and Srinivasan, V. (1990). Conjoint analysis in marketing: new developments with implications for research and practice. *Journal of Marketing, 54* (4), 3-19.

Hrastinski, S. (2008). Asynchronous and synchronous e-learning, *Educause Quarterly, 31* (4), 51-55.

Johnson, R., and Orme, B. (2003). *Getting the Most from CBC*. Sawtooth Software Research Paper Series. Retrieved on May 7, 2013 from http://www.sawtoothsoftware.com/download/techpap/cbcmost.pdf.

Jonassen, D. H., and Land, S. (2000). *Theoretical foundations of learning environments, (1st ed.).* Mahwah, NJ: Lawrence Erlbaum Associates.

Karayan, S. S., and Crowe, J. A. (1997). Student perceptions of electronic discussion groups, *THE Journal, 24* (9), 69-71.

Kerlinger, F. N. (1986). *Foundations of behavioral research, (3rd ed.)*. New York, NY: Holt, Rinehart and Winston.

Knowles, M. S., Holton, E. F., and Swanson, R. A. (2011). *The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development (7th Ed.)* Burlington, MA: Butterworth-Heinemann.

Maor, D. (2003). The teacher's role in developing interaction and reflection in an online learning community. *Educational Media International, 40* (1-2), 127-138.

Mason, R. (2006). Learning technologies for adult continuing education. *Studies in Continuing Education, 28* (2), 121-133.

Massy, W. F., and Zemsky, R. (1995). Using information technology to enhance academic productivity. In the *Proceedings of the Wingspread Enhancing Academic Productivity Conference* (June 1995). Retrieved on August 15, 2013 from http://net.educause.edu/ir/library/html/nli0004.html.

McCormick, S. (1999). The case for visual media in learning. *Syllabus Magazine, 13* (1), 55-57.

Ong, C. S., and Lai, J. Y. (2006). Gender differences in perceptions and relationships among dominants of e-learning acceptance. *Computers in Human Behavior, 22* (5), 816-829.

Orme, B. K. (2006). *Getting Started with Conjoint Analysis (2nd ed.)*. Madison, WI: Research Publishers.

Parker, K. R., and Chao, J. T. (2007). Wiki as a teaching tool. *Interdisciplinary Journal of Knowledge and Learning Objects, 3* (1), 57-72.

Privateer, P. M. (1999). Academic technology and the future of higher education: Strategic paths taken and not taken. *Journal of Higher Education, 70* (1), 60-79.

Rogers, D. L. (2000). A paradigm shift: Technology integration for higher education in the new millennium. *AACE Journal, 1* (13), 19-33.

Schaupp, L. C., and Bélanger, F. (2005). A conjoint analysis of online consumer satisfaction. *Journal of Electronic Commerce Research, 6* (2), 95-111.

Simonson, M. R., Smaldino, S., Albright, M., and Zvacek, S. (2000*). Teaching and Learning at a Distance (4th ed.)*. Upper Saddle River, NJ: Merrill/Prentice Hall.

Smith, D., and Hardaker, G. (2000). E-learning innovation through the implementation of an internet supported learning environment. *Educational Technology & Society 3* (3), 422-432.

Smith, M. K. (2002). Malcolm Knowles, informal adult education, self-direction and andragogy. *The Encyclopedia of Informal Education*. Infed. Retrieved on June 1, 2013 from www.infed.org/thinkers/et-knowl.htm.

Srinivasan, V. (1988). A conjunctive-compensatory approach to the self-explication of multiattributed preferences. *Decision Sciences, 19* (2), 295-305.

Thurlow, C., Lengel, L., and Tomic, P. A. (2004). *Computer Mediated Communication: Social Interaction and the Internet*. Thousand Oaks, CA: Sage.

Tosh, D., and Werdmuller, B. (2004*). ePortfolios and Weblogs: One Vision for ePortfolio Development*. Retrieved on May 1, 2012 from http://www.morrisville.org/classrooms_curriculum/hive_portal/documents/ePortfolio_Weblog.pdf.

Turoff, M. (1989). The anatomy of a computer application innovation: Computer mediated communications (CMC). *Technological Forecasting and Social Change, 36* (2), 107-122.

Weller, M., Pegler, C., and Mason, R. (2005). Use of innovative technologies on an e-learning course. *The Internet and Higher Education, 8* (1), 61-71.

Xu, D., and Jaggars, S. S. (2011). *Online and Hybrid Course Enrollment and Performance in Washington State Community and Technical Colleges*. Community College Research Center Working Paper No. 31, Teachers College, Columbia University.

Editor's Note:

This paper was selected for inclusion in the journal as a ISECON 2013 Distinguished Paper. The acceptance rate is typically 7% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2013.

In Search of Design-Focus in IS Curricula

Jeffry S. Babb
jbabb@wtamu.edu
Computer Information and Decision Management
West Texas A&M University
Canyon, TX 79106 USA

Leslie J. Waguespack
lwaguespack@bentley.edu
Computer Information Systems Department
Bentley University
Waltham, Massachusetts 02452, USA

Abstract

Curricula in information systems embrace a broad range of topics that leave the identity of information systems as a discipline somewhat in flux. In the spirit of "the first among equals," we posit that design should have preeminence in the education of information systems professionals. Design frames problem understanding and defines what system's quality means. It behooves our profession to prepare designers who deliver systems that not only "work," but also deliver systems that society will recognize as "working well." The research community recognizes this as reflected in a renewed interest in design science research and in information systems design theory. While our discipline has been recently reshaped by offshoring, outsourcing, and service-oriented architectures, which provide myriad options for managing information in organizations, design persists as a central aspect of the discipline. This is so as information systems design remains close to stakeholders because design materializes an organization's core business model and strategy. This paper contemplates a design-focused IS curriculum and postulates a perspective on design that values the subjective sensibilities of stakeholders as well as an objective, algorithmic depiction of computing. The latter has shaped the classic education of a developer as a master of technology while the former nurtures an aesthetic awareness that captures nuances of stakeholder satisfaction and a more inclusive conception of system quality. The skillset of designers is a superset of that of developer and as such, a designer must be craftsman and more, a reflective practitioner skilled in the art of generative metaphor.

Keywords: Information Systems Curriculum, Information Systems Design, Thriving Systems Theory, Reflective Practice, Mastery learning.

1. INTRODUCTION

Design is not a core focus in contemporary information systems (IS) education (Waguespack, 2011). Yet it is a palpable force in the evolving role of computing in the everyday life of individuals, organizations, and business and, in many cases, has redefined normality as we know it (Christiansen, 1997). For example, as a company, Apple Inc. has been important not just as a technology leader, nor just as an innovative leader in the marketplace, but particularly for a marked, tenacious, and overt focus on the importance of design (Turner, 2007). Design is a central subject in the arts, and particularly in architecture (Alexander, 2002). Design delves into the human's capacity for subjectivity and aesthetic experience that does not succumb readily to the measuring tape or the algorithm. Despite its seeming absence from most programs in IS, design is what separates a system that "works" from a system that "works well!" – a sentiment perhaps most forcefully set forth by Fred Brooks:

Whereas the difference between poor conceptual designs and good ones may lie in the soundness of design-method, the difference between good designs and great ones surely does not. Great designs come from great designers. Software construction is a creative process. Sound methodology can empower and liberate the creative mind; it cannot inflame or inspire the drudge (Brooks, 1987).

In this light, of both design's emphatic impact on computing's role in everyday life and the challenge of developing great designers, this paper explores formulating a design-focused IS curriculum based upon a design perspective that values the subjective sensibilities of stakeholders as well as an objective, algorithmic depiction of computing. We assert the centrality of design even despite the changes wrought upon IS manifested in the outsourcing/offshoring of construction, the rapid emergence of the pervasive and ubiquitous computing brought by mobile computing, and a trend towards service-oriented architectures (Babb and Keith, 2012).

This paper proceeds as follows: First, we begin with a brief, selected review of relevant design research. We next argue the centrality of design in information systems to address the essential difficulties of the IS domain. We follow the influence of Christopher Alexander's living structures theory of design to introduce subjectivity as an integral aspect of design quality and use Thriving Systems Theory's (Waguespack, 2010) design quality clusters to further contemplate the role of subjectivity in design. We then review perspectives on learning and action, for pedagogy and practice, utilizing guidance from Argyris and Schön (1974, 1978, 1996), describing how reflective practice illuminates the progression from student to master. Two extant college programs are used to illustrate a focused apprenticeship/craftsmanship model that may be better suited to developing pedagogy for design. We conclude considering next steps required to formulate IS education with design at its center.

2. DESIGN IN INFORMATION SYSTEMS RESEARCH AND CURRICULA

IS, as a discipline, has been in flux for some years (Alter, 2008; Benbasat & Zmud, 2003; Walsham, 1993). If anything, design as a focus has diminished in IS curricula rather than grown. If we inspect IS model curricula as surrogates for defining the discipline it is clear that "… [the] distinction between design and implementation has faded from the structure of computing education. To ignore the conceptual distinction between the *design* and an *implementation* is tantamount to accepting any "solution" without even considering [quality]…" (Waguespack, 2011)

In IS research, however, there is a renewed interest in design; a recognition that design quality should not be an insignificant or accidental result of systems development. Design Science research has grown into a movement (Hevner & Chatterjee, 2010) and Information Systems Design Theory (ISDT) is finding shape as a means of promoting quality systems. (Walls, 2004, Gregor, 2007)

Design (as manifested in object-oriented programming) has drawn guidance from physical art and architecture in Christopher Alexander's pattern languages and the notion of design patterns (Alexander, 1977, 1979; Gamma et al., 1995). Alexander advocates, as a prime aim of design, to search for the "Quality without a Name," or perhaps, a "je ne sais quoi" which captures the essence of designing. That is, to speak of design is to speak of quality (Alexander, 1979). Alexander's theory of *living structure* underpins Thriving Systems Theory of design quality in information systems (Alexander, 2002; Waguespack, 2010; Waguespack & Schiano, 2012, 2013). We can draw an arc of design influence from Christopher Alexander, to the "Gang of Four," to Ward Cunningham and Kent Beck, as manifested in object-orientation, the Unified Modeling Language, design patterns, and agile methodologies. (Beck et al., 2001)

3. CENTRALITY OF DESIGN

Generally speaking, the predominant heritage of IS design closely aligns with the positivist philosophy of mechanistic or mathematical artifacts that is indifferent to any subjective or aesthetic qualities. This attitude proceeds from the natural sciences that focus on explaining extant physical and biological structures. At their core, the natural sciences are about determining "why" objects in nature exist as they do – basically taking intact, functioning "objects" apart to see what they are made of and how they work. For the most part these objects would exist with or without human attention. Information systems, however, are artificial in that they manifest as "things" that exist beyond the "natural" world

Information system artifacts do not exist independent of humans and human organization. They are human-made and reside in a sociological context where they evoke some degree of human satisfaction based on the value individuals or society perceives in them (the business moniker might be "cost/benefit"). The "value" of an object in the natural sciences view vests in its existence and/or survival with any human satisfaction based on "accident of nature." In contrast, the very existence of an information system (a human-made artifact) depends upon its value as perceived by a society of stakeholders (ostensibly that value is the reason the system was constructed). Therein lies the essential difficulty of IS design, meeting the human conception/perception of value and satisfaction: quality. In this sense, it is appropriate to say that design holds the central role in information system success.

Designing quality in IS artifacts entails: 1) a grasp of functional needs, 2) an aesthetic sensibility attuned to the stakeholder(s)' perception of quality and 3) the skill to engage technology that allows a formulation of (1) which allows (2) to resonate. Design in this formulation of quality is central to the entire IS discipline: technology, society, organization, management, and operation – every relevant aspect of IS.

Design and Subjective Resonance

Thriving Systems Theory (TST) is an emergent design theory that promotes specific emphasis on aesthetic sensibility that is attuned to the stakeholder(s)' perception of quality (Waguespack & Schiano, 2013). TST rests on three pillars of theory: Christopher Alexander's *living structure* in *The Nature of Order* (Alexander, 2003); Lakoff and Johnson's cognitive-linguistics and conceptual metaphor that explain human understanding and perception (Lakoff, 2008); and Fred Brooks' essence and accidents in systems development (Brooks, 1987).

"Everything that can be counted does not necessarily count; everything that counts cannot necessarily be counted." – Albert Einstein

TST's emphasis on subjectivity and aesthetics relies upon three concepts: 1) human perception is mediated by innate conceptual metaphors through which we recognize ordered-ness, 2) the transmission of ideas through any form of human communication is imperfect and therefore all communication is metaphorical, and 3) any conception of reality is incomplete therefore satisfactory communication relies on conscious and careful abstraction (Waguespack, 2010).

TST translates fifteen properties of design, identified by Alexander (1979), that convey a sense of *living structure* into the context of information systems. An analysis of the supporting relationships among the choice properties of TST exposes property clusters and weaving patterns of resonance that exhibit discernible design qualities. The clusters compose a hierarchical arrangement, a combining of resonance that converges to a comprehensive confluence of design affect.

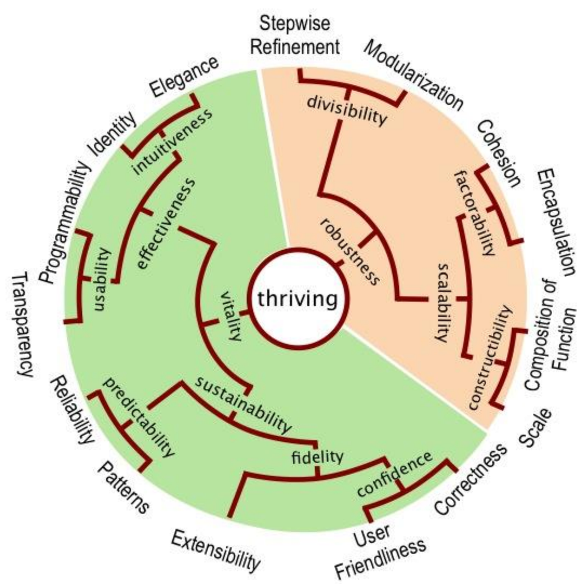

Figure 1. Choice Property Clusters

In Alexander's theory, it is in the ultimate confluence of these properties that an observer perceives a degree of *wholeness* in the design – a level of satisfaction that presages design quality. TST assigns names that denote the constituent properties. In Figure 1 the choice properties line the perimeter while the clusters converge toward the center of the diagram in four levels of confluence exposing two "families" of quality, robustness and vitality, which fuse into the quality that is the design theory's namesake, thriving.

A full exposition of the choice property clusters, the rationale for naming them, and the effect of their confluence of their constituent choice properties is found in Waguespack (2010).

4. DECOMPOSING DESIGN

We propose two dimensions of design competency in order to explore design-centric IS pedagogy: 1) the breadth of design quality addressed and 2) the depth of skill/expertise in realizing these qualities in artifact design. The skill/expertise dimension represents an accumulation of knowledge, but also implies an aspect of "absorption" to indicate what might be a reasonable expectation for a particular "learner."

Figure 2. Design Quality's Relationship With Skill/Expertise Level

Generally, only the most sophisticated of students would be able to address design in the abstract without a specific context or application domain. Accordingly, we stipulate that there must be some prerequisite domain knowledge to serve as a "sandbox" within which to demonstrate and practice design concepts where the student already recognizes domain objects and has some idea of their role and inter-relationships. Thus, design requires the acquisition and skillful utilization of domain knowledge. Within this context the scale of skill/experience might be described as in Table 1 intimating the individual's ability to understand and/or construct an artifact in a particular domain.

Skill/Expertise Level	Competency
Master	Authoritatively knowledgeable
Professional	Trusted practitioner
Journeyman	Trained practitioner
Apprentice	Student in training
Novice	Beginning student
Consumer	A user of the product artifact

Table 1. Skill/Expertise Competency

Among the design qualities of TST, novices will find the "robustness" design quality family easier to absorb because they express concepts of design that are more tractable. Indeed, many might argue that these are the very design "principles" that have traditionally shaped the curricula of systems development in computer science and information systems.

The "robustness" quality family can be demonstrated directly in the examination of entry-level software development coursework: programming, data structures, and computer organization, etc. This family gives the impression (at least to students) of rather static qualities and thus is often characterized as structural. There are convenient visual representations – static diagrams or charts – that allow students to learn to recognize design (noun) elements. When the time comes to ask the student to "create" a solution rather than understand an existing one – that is the point when the student engages "design" (verb). Up until that point we've only tasked them to "recognize" design (noun). The difference is not subtle. Every IS educator sees students who don't make the transition from recognition to performance readily and some fail to make this important transition at all.

Turning our attention to the "vitality" quality family, students must recognize a dynamic rather than static quality of "behaving" or "evolving" – as in Alexander's (1977, 1979) conception of *living structure*. These concepts are not so easily represented in diagrams or charts, as there is conceptual "movement" that needs to be "seen." There is some potential for "stop-motion" as in sequence diagrams in UML. But the full import of extensibility or reliability is

a quality of "movement" or "evolution" requiring imagination on the part of the student. They must "compose" a mental image of the concept that captures a variety of implications that stem from vitality design qualities and will impact the artifact's users and stakeholders.
Many of the TST/Alexander design qualities are too challenging for students at the lower skill/experience levels (novice or apprentice) to fully absorb, comprehend, or appreciate; since they probably don't have a broad or deep enough grasp of the application domain objects sufficient to recognize the nuances explained by the clusters. It is this grasp of the design qualities' impact on satisfaction that sets apart the upper skill levels (professional and master). That is, a designer generatively and iteratively evolves towards these higher orders through years of "conversing with" these materials of design (Schön, 1987).

As students and practitioners progress along the axis of professional maturation towards mastery, "imaginative visualization" becomes a key aspect of abstract thinking – a challenge for teachers as much as students when it comes to conveying abstract ideas. Moreover, much of this maturation will transpire *in situ,* in practice, as expertise continues to develop long after the classroom and laboratory experiences fade. An imagination is important as it is a "way of seeing" and, perhaps, "not seeing" that shapes design. That is, imagination is a means for matching experience to a new and/or wider context (Mills, 1959).

Curiously or coincidentally enough, this ability to wield imagination is itself a design challenge. This is "abstract thinking" as in "object think" or "relational think" where the mental image of the problem space provides the building blocks of the paradigm. This is, in another name, *metaphor-driven* where each individual has her own image of a concept seeking aspects of consistency that others will recognize and share the concept (Lakoff, 2008, Waguespack, 2010). This is a critical pedagogical challenge: how does a student's capacity for *abstract thinking* or *thinking metaphorically* develop? Reflective practice offers a promising protocol.

5. EDUCATING THE REFLECTIVE DESIGNER

Graduates of IS programs usually obtain employment and career-building experiences based upon the technical and construction skills they develop in (and out of) the classroom. But what are the seeds that should be planted and nurtured that precipitate higher orders of imagination, invention, problem solving – quality design?

Argyris and Schön (1974, 1978, 1996) and Schön (1983, 1987) research the individual and collective competencies that facilitate the generative process of learning that leads to mastery. They prescribe three specific competencies:

1) **Generative Metaphor** (Schön, 1983; 1987)
2) **Reflective Practice** (Schön, 1983; 1987)
3) **Double-Loop Learning** (Argyris and Schön, 1974, 1978, 1996)

While not exhaustive, these theoretical lenses pose a means to understand, in action, the various daily habits, norms, and competencies that can augment technical instruction to encourage and facilitate learning in IS students and practitioners in advancement toward mastery.

Generative Metaphor

Design quality relies heavily on the role of metaphor to achieve stakeholder satisfaction. Thriving Systems Theory asserts that a thriving system is the result of models (metaphors) that capture and reflect the stakeholders' intentions along with careful choices of applying technology that resonate in the design (Waguespack, 2010).

Schön offers insight into these relationships with his concept of "generative metaphor" (Schön, 1993). A generative metaphor sets the problem in context with a "naming and framing" process. Metaphor, in this case, is used in a manner very similar to Lakoff's (2008) conception, as a projection of the problem in terms of a familiar surrogate. The metaphor names and frames the problem, proposing a set of potential solutions and priming a series of attempts to map these known solutions onto this problem. For instance, it is possible to characterize the run-down nature of a neighborhood by describing the neighborhood as "blighted." Since blight is typically used as a term to describe disease in plants (and other organisms), setting this problem, metaphorically, reveals "treatment" approaches to that problem. The designer's choice of metaphor maps her past solution experience onto this problem and adjusts the solution's treatment to the differential.

Reflective Practice

Schön introduces *Theory of Action* (Argyris and Schön, 1974, 1978, and 1996) concepts of thinking in and thinking on action to develop a model of a reflective practitioner (Schön, 1983, 1987). Reflective practice is about building professional repertoire, particularly for those whose professional activities involve design. Both imagination and intuition develop through daily experimentation and reflection, reflecting *while doing* and *after doing* in a cycle that allows for error detection and correction. Reflective practice is a generative loop of discovery, classification, and application.

The practitioner allows himself to experience surprise, puzzlement, or confusion in a situation which he finds uncertain or unique. He reflects on the phenomenon before him, and on the prior understandings which have been implicit in his behavior. He carries out an experiment which serves to generate both a new understanding of the phenomenon and a change in the situation. (Schön 1983: 68)

In reflective practice, the designer builds repertoire – a collection of concepts, ideas, visuals, examples, mistakes and actions – to draw upon in subsequent decision-making and designing.

When a practitioner makes sense of a situation he perceives to be unique, he sees it as something already present in his repertoire. To see this site as that one is not to subsume the first under a familiar category or rule. It is, rather, to see the unfamiliar, unique situation as both similar to and different from the familiar one, without at first being able to say similar or different with respect to what. The familiar situation functions as a precedent, or a metaphor, or… an exemplar for the unfamiliar one. (Schön 1983: 138)

Double-Loop Learning

Argyris and Schön's (1974, 1978, 1996) double-loop learning addresses the problem of ill-suited frames, metaphors that lead to habits and perspective that overlook key design quality aspects. Schön's collaboration with Argyris also centers on professional effectiveness. Professionals (e.g. designers) have mental maps governing their actions in situations. From these maps they (overtly and tacitly), plan, implement, and review their actions. These maps guide actions through intuition rather than any explicitly espoused theories explaining their actions. This often results in a split between theory and action – what people "say" they do and what they actually do. Argyris and Schön (1974, 1978, 1996) characterize two theories of action: one in which personal theories of action are implicit in daily practice (a *theory in use*), and another that is used when our actions are described to others (*espoused theory*). Correctly aligning these two theories in the student learner helps to build a useful repertoire for designing.

Smith (2011) describes the elements driving the development, utilization, and perpetuation of theories of action:

Governing variables: these are dimensions, such as the design qualities, that an individual (such as a designer) is trying to balance and harbor within acceptable and desirable limits. Actions taken are likely to impact these variables in a manner where the designer engages in trade-off behaviors to manage and balance impacts to governing variables.

Action strategies: The general patterns of behavior and action used to maintain acceptable balance among their governing variables.

Consequences: The outcomes, intended and unintended, associated with action.

These theories of action are instructive for educating and developing designers. According to Argyris and Schön (1978), learning is based upon the detection and correction of error. Upon failure (error detection), a designer seeks new action strategies to maintain presumed balances among governing variables. That is, the designer may not challenge given or chosen goals, values, plans and rules (perhaps a premise that an OOP design is *always* superior to a procedural design). This unquestioning behavior is what Argyris and Schön (1974) call "single-loop" learning. An alternative and more desirable learning mode is where the practitioner is open to questioning assumptions about the governing variables themselves. To scrutinize and challenge these assumptions is called "double-loop" learning. A grasp of the design qualities

and how they resonate (or fail to resonate) with stakeholder intentions informs assumption challenging and assures that the stakeholder intentions as presented reflect *theory in use* rather than *espoused theory*. An illustration of this process, particularly as it relates to organizational learning, is described as follows:
When the error detected and corrected permits the organization to carry on its present policies or achieve its present objectives, then that error-and-correction process is single-loop learning. …Double-loop learning occurs when error is detected and corrected in ways that involve the modification of an organization's underlying norms, policies and objectives (Argyris and Schön, 1978: 2-3).

Single-loop learning would be normative when goals, values, frameworks and, to a significant extent, strategies are taken for granted (Smith, 2011). That is, the designer simply focuses on the efficiency of techniques; those most likely found within the robustness family of design quality (Usher and Bryant, 1989: 87). The shortcoming in single-loop learning is that all reflection is directed toward making existing strategies more effective. With double-loop learning, the naming, framing, and metaphor protocol that underlies repertoire are subject to critical review and open to alternative strategies. Agile software development (and design) methods, XP and Scrum in particular, incorporate double-loop learning through critical review, although this behavior is often under-engaged or reverts to simple single-loop behaviors (Babb, Hoda, & Nørbjerg, 2013).

6. FORMING DESIGN PEDAGOGY

The discussion of reflective action suggests protocols to enhance learning and reflective practice by building repertoire that advance toward mastery. Effective design pedagogy should be based on theory and experience both grounded in quality, immersion, craftsmanship, and lessons from guilds.

Quality

Although the science of management leans toward a positivist inclination of quantification, our experience is that workers or "makers" have qualitative competencies and skills in their repertoire essential to production. Despite automating a significant degree of production, design remains in the context of doing, of making, and of taking action. In information systems, "… [*designers*] have a kind of knowledge that is distinct from the knowledge that managers have…" which informs a profound way of seeing their discipline (Hummel, 1987). Where many stakeholders view the IS discipline as managerial, a design perspective requires that we understand IS as an endeavor of *doing*. It is in this sense that Schön (1983, 1987) provides an empirical perspective on what happens as professionals act. To achieve quality in design the professional must have a theory of quality that guides her decisions. Because of its explicit inclusion of aesthetics, we believe that Thriving Systems Theory is a viable candidate design theory for design pedagogy.

Immersion

Quality, although a worthy aim of standards and regulation, is still quite a subjective affair. Thus, quality pedagogy cannot be realized if unaccompanied by domain knowledge, technical skills, and techniques and their requisite training. These are intrinsic to mastery, as in the performing arts (e.g. music and athletics); one must practice and undertake instruction with some theory of quality as a goal. In a collegiate setting, where basic IS instruction transpires, immersion is a desirable protocol for inculcating both robustness and vitality qualities defined in Thriving Systems Theory.

There are very few contemporary examples of the immersive approach in four year baccalaureate IS programs. The IS program at Brigham Young University in Utah is one – in an AASCB-accredited college of business. Students spend the first two years completing both university core and a pre-business curriculum. In the fall of the junior year, students are placed into 5-student cohort teams and engage in an immersive study of programming, analysis and design, networking, business process analysis, data management, and enterprise architecture. At the conclusion of the fall semester, these teams engage with real-world clients in a design competition. Faculty and industry partners judge the product quality. In the following term the teams implement their designs. These students are well prepared for design-relevant internships during their junior-into-senior summer. Their senior year completes their business core with their foundation in information systems fully formed. Many students move on to an accelerated Master's program. The immersion approach of BYU program facilitates imprinting a pattern of repertoire development on every student and sets them on a firm footing for their continued maturation toward a master designer.

Apprenticeship

Apprenticeship is pedagogy based upon teacher/student relationships that are one on one or one on few. The arrangement promotes the immediacy of feedback in the double-loop learning protocol. During the 2004 to 2005 academic year at New Mexico Highlands University an innovative curriculum committed to the apprenticeship model – the Software Development Apprenticeship (SDA) (Rostal & West, 2006). It too was an immersive program modeled on the developmental concept of apprenticeship as a progression toward mastery. The curriculum focused on agile software development methodology. Organized in cadres by experience, those students more advanced in the program provided systematic and formal guidance to novice and apprentice students. The small number of students and faculty allowed the immersive curriculum to focus on self-governance, learning-from-doing and learning-from-learning with mastery as an explicit goal. The program emphasized: 1) a focus on people (and their inherent subjectivity with respect to quality); 2) systems thinking enfolding the stakeholders with the artifact; 3) agility focusing on outcomes; 4) craftsmanship recognizing quality as the goal of design; and 5) a focus on software as the central medium by which systems come to fruition.

The program adhered to the university's curricular framework that presented a challenging environment for the program designers. Yet they crafted a unique experience that inspired students to succeed both as undergraduates and practicing professionals on live contracted client engagements.

Craftsmanship

Apprenticeship underscores the importance of tacit knowing through experience, through exposure, and through a mature repertoire. This is most difficult to achieve in the disjointed, bifurcated curricular designs that are common in today's IS related programs. Both BYU and New Mexico Highlands University illustrate innovative curricular design representing a design-centric view of our discipline. They demonstrate immersion consistent with the traditional and time-honored pedagogy of apprenticeship.

An apprenticeship model sets the student's personal experience in action as the primary source of learning. In their own behavior the instructor/master coaches model double-loop learning as a virtuous (quality focused) pattern of reflective practice. The result is a repertoire of habits and norms grounded in actual problem solving experience using the IS tools, techniques, and skills required of the design craft; then evaluated against professional expectations. Personal experience in *action* operationalizes the combination of quantity and quality as part-and-parcel of practicing craft. This accentuates the perception of technology and tools as implements of design but not substitutes for it. Despite advances in tools that greatly automate and facilitate the process, the act of designing systems is still very much rooted in the conceptual, in the imagination that is often labeled "creativity." As such, regardless of the "industrialization" of the discipline, design remains an endeavor grounded in human touch and craft.

Lessons from Craft Guilds

Craft guilds from medieval times served several useful purposes relevant to the pedagogy of design. Wolek (1999a, 1999b) proposes that pre-industrial craft guilds rested on three foundational principles: 1) regulation; 2) standards of accomplishment; and 3) apprenticeship. Despite any romantic notions of craft and guilds, most guilds served important needs by promoting trade, creating clear quality-driven theories establishing and recognizing mastery, and regulation of practice to promote quality.

Whereas there may have been unique social and historical contexts for the collaborative labor action that were trade/craft guilds, these guilds were effective in developing a solidarity and shared pride in craft that encouraged both innovation and mastery (Wolek, 1999a). Guilds regulated craft such that quality could be defined and improved to promote a professional sense of commerce, quality, resources, product attributes, and process. The positive aspects of guilds were that they established benchmarks for quality and frameworks for improving the craft.

Thriving Systems Theory, as an information systems design theory, adopts the blended emphasis of the objective and aesthetic expression of quality from Alexander (1977,

1979). The qualities and the choice properties that underlie them in TST offer a starting point to study and teach design. The craft and trade guilds teach us that standards can emerge from subjectivity of this sort (Wolek, 1999a).
Among the most important lessons from guilds is the commitment to apprenticeship. The aspects of competence, pride, personal responsibility, and behavioral modeling cannot be overlooked. An apprenticeship represents determined study, tenacious action, focused instruction and correction, and immersion into the tools and ways of craft that lead to both robust and vital design. A master designer does not arrive as such through casual engagement. This focused vision of learning and mastery deserves a presence in design pedagogy.

7. CONCLUSION

We argue that design holds a central importance in the discipline of information systems and that importance should be clearly and distinctly reflected in IS pedagogy. The quality experience society deserves from the information systems that are shaping culture, commerce, and lifestyle must address human sensibilities and aesthetics; lessons widely missing from the IS curricula today. Although much of the learning necessary for IS professionals is both theoretical and technical, all of the systems our students produce, augment, or maintain owe most of the quality that stakeholders and users experience in them to enlightened and well-practiced design.

Thriving Systems Theory is a likely candidate for infusing subjective aspects of quality into design pedagogy. The opportunities represented in reflective practice, double-loop learning, and immersive and apprenticeship learning protocols will require the innovative curricular efforts demonstrated by BYU and New Mexico Highlands. These exemplars stand as feasible and effective prototypes.

This paper promulgates a perspective from which both dialog and curriculum design may begin. The IS profession needs a curriculum that facilitates a design-based IS education focused on reflection, inclusive of both aesthetics and function, and promoting a professional progression based on an apprenticeship/craftsmanship model. Our hope is that this discussion will advance development of a curriculum model centered on design with pedagogy preparing students to grow into professional designers who will design systems that thrive.

8. REFERENCES

Alexander, C., Ishikawa, S. & Silverstien, M. (1977). A Pattern Language: Towns, Buildings, Construction. Oxford University Press, London.

Alexander, C. (1979) *The Timeless Way of Building*, Oxford University Press, London.

Alexander, C. (2002). *The Nature of Order An Essay on the Art of Building and the Nature of the Universe:* Book I - The Phenomenon of Life, The Center for Environmental Structure, Berkeley, CA, 2002.

Alter, S. (2008). Defining information systems as work systems: implications for the IS field. *European Journal of Information Systems*, 17(5), 448-469.

Argyris, C., Schön, D.A. (1974). *Theory in Practice: Increasing Professional Effectiveness*. Jossey-Bass, San Francisco

Argyris, C., Schön, D.A. (1978). *Organizational Learning: a Theory of Action Perspective*. Addison-Wesley, Reading, Mass.

Argyris, C., Schön, D.A. 1996. *Organizational Learning II: Theory, Method and Practice*. Addison-Wesley, Reading, Mass.

Babb, J. S., Hoda, R., & Nørbjerg, J. (2013). Barriers to Learning in Agile Software Development Projects. In Baumeister, H., & Weber, B. (Eds.), *Agile Processes in Software Engineering and Extreme Programming*. 1-15. Heidelberg: Springer

Babb, J. S., Keith, M. (2012). Co-Creating Value in Systems Development: A Shift towards Service-Dominant Logic. *Journal of Information Systems Applied Research*, 5(1), 4-15.

Beck K., Beedle M., van Bennekum A., Cockburn A., Cunningham W., Fowler M., Grenning J., Highsmith J., Hunt A., Jeffries R., Kern J., Marick B., Martin R.C., Mellor S., Schwaber K., Sutherland J., & Thomas D. (2001). *Manifesto for Agile Software Development*. Retrieved June 26, 2013 from agilemanifesto.org

Benbasat, I., & Zmud, R. W. (2003). The identity crisis within the IS discipline: Defining and communicating the discipline's core properties. *MIS quarterly*, 27(2) 183-194.

Christensen, C. M. (1997), *The innovator's dilemma: when new technologies cause great firms to fail*, Harvard Business School Press, Boston, Massachusetts, USA.

Fowler, M. (2002). *Patterns of Enterprise Application Architecture*, Addison-Wesley, Boston.

Gamma, E., Helm, R., Johnson, R., and Vlissides, J. (1995). *Design Patterns: Elements of Reusable Object-Oriented Software*. Addison-Wesley, Boston.

Gregor, S. & Jones, D. (2007). The Anatomy of a Design Theory. *Journal of the Association for Information Systems*, 8(5), 312-335.

Hevner, A. and Chatterjee, S. (2010). *Design Research in Information Systems: Theory and Practice*, Springer, New York, NY.

Hummel, R. P. (1987). Behind quality management: What workers and a few philosophers have always known and how it adds up to excellence in production. *Organizational Dynamics*, 16(2), 71-78.

Kahneman, D. & Klein, G. Conditions for Intuitive Expertise. *American Psychologist*, 64(4), 515-526.

Lakoff, G., & Johnson, M. (2008). *Metaphors we live by*. University of Chicago press, Chicago.

Medina, R. (2008). Christopher Alexander still matters. http://www.regismedina.com/blog/2008/04/christopher-alexander-still-matters. Accessed June 15, 2013.

Mills, C.W. (1959). *The Sociological Imagination*. Oxford University Press, Oxford.

Naur, P. (1985). Programming as theory building. *Microprocessing and Microprogramming*, 15(5), 253-261.

Quillien, J., Rostal, P., and West, D. (2009). Agile anthropology and Alexander's architecture: an essay in three voices. *Proceedings of the 24th ACM SIGPLAN conference on Object oriented programming systems languages and applications (OOPSLA '09)*. 44(10), 529-546.

Quillien, J. & West, D. (2010). Rubber ducks, nightmares, and unsaturated predicates: proto-scientific schemata are good for agile. *Proceedings of the ACM international conference on Object oriented programming systems languages and applications (OOPSLA '10)*. ACM, New York, NY, USA, 901-917.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books, New York.

Schön, D. A. (1987). *Educating the reflective practitioner*. Jossey-Bass, San Francisco.

Schön, D. A. (1993) Generative metaphor: A perspective on problem-setting in social policy. In Ortony A. (Ed.) *Metaphor and Thought*, Cambridge University Press, Cambridge University, 137-163

Smith, M. K. (2011). Donald Schön: learning, reflection and change, *the encyclopedia of informal education*. http://www.infed.org/thinkers/et-schon.htm. Retrieved: 06/20/2013.

Taverniers, M. (2002). *Metaphor and metaphorology: a selective genealogy of philosophical and linguistic conceptions of metaphor from Aristotle to the 1990s (Vol. 1).* Academia Press.

Turner, D. (2007). The secret of Apple design. MIT Technology Review. http://www.technologyreview.com/featuredstory/407782/the-secret-of-apple-design/. Accessed June 15, 2013.

Usher, R., & Bryant, I. (1989). *Adult education as theory, practice and research: The captive triangle*. Routledge, London.

Waguespack, L.J. (2010). *Thriving Systems Theory and Metaphor-Driven Modeling*. Springer-Verlag, London.

Waguespack, L. (2011). Design, The “Straw” Missing From the “Bricks” of IS Curricula. *Information Systems Education Journal,* 9(2) pp 101-108. http://isedj.org/2011-9/ ISSN:

1545-679X. (A preliminary version appears in The Proceedings of ISECON 2010)

Waguespack, L.J. & Schiano, W.T. (2012). SCRUM Project Architecture and Thriving Systems Theory. *45th Hawaii International Conference on System Science (HICSS)*, 4943-4951, 4-7 Jan. 2012

Waguespack, L.J. & Schiano, W.T. (2013). Thriving Systems Theory: An Emergent Information Systems Design Theory. *46th Hawaii International Conference on System Science (HICSS)*, pp.3757,3766, 7-10 Jan. 2013

Walls J.G, Widmeyer, G.R. & El Sawy, O.A. (1992). Building and Information System Design Theory for Vigilant EIS. *Information Systems Research*, 3(1), 36-59.

Walls J.G, Widmeyer, G.R. & El Sawy, O.A. (2004). Assessing Information Systems Design Theory in Perspective: How Useful was our 1992 Initial Rendition? *Journal of Information Technology Theory and Application*, 6(2), 43-58.

Walsham, G. (1993). *Interpreting information systems in organizations*. John Wiley & Sons, Inc.

West, D. and Quillien, J. 2011. Patterns for Story Craft. February 2011. ACM 22 pages.

West, D., Rostal, P., & Gabriel, R. P. (2005, October). Apprenticeship agility in academia. *In Companion to the 20th annual ACM SIGPLAN conference on Object-oriented programming, systems, languages, and applications,* 371-374.

Wolek, F. W. (1999a). The managerial principles behind guild craftsmanship. *Journal of Management History (Archive)*, 5(7), 401-413.

Wolek, F. W. (1999b). Ye olde total quality management. *Total Quality Management*, 10(7), 1077

Gender Rationales in Selecting a Major in Information Technology at the Undergraduate Level of a University Program: A Focus Group Approach

Sushma Mishra
mishra@rmu.edu

Peter Draus
draus@rmu.edu

Donald Caputo
caputo@rmu.edu

Gregory Leone
leone@rmu.edu

Frederick Kohun
kohun@rmu.edu

Diana Repack
repack@comcast.net

Computer Information Systems Department
Robert Morris University
Moon Township, Pa 15108, USA

Abstract

Previous research studies of women applying to, enrolling and completing computing degrees at the undergraduate collegiate level suggest a significant underrepresentation of females in the Information Technology domain in the past decade. This study employs a focus group approach to the gender gap that encompasses forays into the qualitative perceptions and rationales of women in technology in an attempt to disclose the underlying factors that have led to the loss of a significant resource in the Information Technology workforce, that of the female contingent.

Keywords: Women in computing, focus group, qualitative study, strategies for recruitment, mentoring

1. INTRODUCTION

Despite expanding opportunities, substantial financial incentives and increased emphasis on STEM disciplines, women are significantly underrepresented at both the collegiate and professional levels of the Information Sciences.

Yet, recent statistics (Armstrong, 2009) report that women earn nearly 60% of university degrees in the United States, are slightly more than half of the workforce, and still account for only 18% of graduates in the Information Technology field. In order to uncover and categorize the underlying problems of female non-participation in IT, we need to look beyond the common and persistent perception that women suffer from "intimidation" and "anxiety" when compared with their male counterparts (Freeman, 2010). Between 2000 and 2008, there was a 79% decline in the number of incoming undergraduate women interested in majoring in computer science. In 2009, 57% of students graduating from college were women, yet only 18% of the students graduating with a computer science degree were female (WIT.org, 2013). As a result, the percentage of professional women in the computer science workforce has been declining over the past decade from a high of 30% in 2000 to less than 22% in 2009. This is an issue that is growing exponentially and has negative implications for our future. In addition to careers directly in the IT field, the use of technology as an organizational infrastructural mechanism to conduct business today in the industries such as banking, retail and insurance is creating a greater implicit demand for more technologically savvy consumers in many industries. The multitude of factors that manifest the female experience in collegiate selection, retention, graduation and placement within the IT major are as diverse and compelling as the universe of Information Technology itself. Gender gaps in usage, prior experience at the K-12 level, attitudinal shifts that were engendered by the emergence of the social media phenomenon and the general pervasive nature of the Internet experience are certainly factors that need to be explored in relation to the culture and how it relates to women.

A primary goal in a research paper of this nature is to find the structure of the collegiate experience that will ultimately enable the IT educators to spark a new generation of female students who are capable, articulate, technically skilled, and infused with the confidence and professionalism required for success in the Information Technology sphere. In the culminating analysis, the authors of this research paper engage the female university student in examining the challenges, barriers, rewards and perceptions of the Information Technology experience. While we are not able to redesign the culture of the IT community, we can perhaps alter the student's perception of her place in its fold. What do women want? We will try to know by asking them. The study was conducted at a medium size northeastern university in the Unites States. The study used focus groups of currently attending women with majors in information technology. The participating students ranged from freshmen to seniors. The research questions used for this study are:

Research Question 1: What are the perceptions of women concerning an information technology/ information sciences degree?
Research Question 2: What are the perceptions of women concerning an IS/IT degree at Robert Morris University?

Research Question 3: What are the perceptions of women concerning a successful career in IS/IT field?

The paper is organized in the following way. The section following the introduction presents a critical review of research literature in the domain of women in computing. The literature review section is followed by the methodology design. This section discusses the focus groups method of research and its use in information systems. It presents the details of the results obtained from focus groups. The implications of results obtained are presented in the discussion section. The implications are presented along with future research directions and conclusions.

2. LITERATURE REVIEW

Female enrollment in computing degrees and thereafter in professional positions is in decline. The computing industry has been traditionally viewed as a male dominated profession. To understand the perception of women and the challenges of this field, a thorough evaluation of the available research literature was performed. McInerney & DiDonato (2008) conducted focus group interviews of information technology students and found that the major influences in choosing a computing major were positive experiences in high school, an aptitude for math, perceived job prestige, encouragement of family members and key teacher input. Students did not have the more negative stereotypes and attitudes toward the field. A female student enrolled in a computing degree is greatly influenced by her reliance on strong interactions with female high school computer teachers/role models for female students (Beyer, 2008).

Female students have viewed a career in computing as a "nerdy" choice. Women expect this field to be dominated with mathematics and programming requirements and consider themselves unfit for a career in this field. Freeman (2010) argues that female college students feel a lack of confidence with computer skills because they had learned less and practiced less with computers than male students, thus becoming more anxious and distanced when using computer technology. Bright (2007) postulated that promising IT students need basic analytical skills, and concentrated interests in science, technology and math, and that computer technology encompassing the K-12 level is a necessary component.

The question arises concerning what can be done to reduce the anxiety of women who are considering college major choices and are uncomfortable about computing due to limitations in their own perceptions. Caputo & Kohun (2002) suggest that curricular innovation was the key element in increasing the enrollment and retention of female students in Computer Information Systems studies. It stemmed from the female student perception of anxiety when confronted with computer technology, particularly in the area of computer programming. On similar ground, Shade & Woszczynski (2010), after conducting in-depth interviews with female CIS majors, suggest strategies for improving the representation of women in all aspects of the IT realm. According to these authors, the major factors in the ultimate perception of the field were better recruiting and retention strategies, the development of mentors, and changes in the presentation of the information-based body of studies.

It has also been argued that women depend on their prior computing experience in making a choice for a major in their educational endeavor. Myrick & Heo (2009), in a study of a small group of female high school students in a specialized computer environment study group determined that pre-collegiate experience and training at an earlier age may cause a noticeable shift in gender equity among CS majors. Adequate training and ease of use with computers does have a major influence on the freshmen perception of computing majors. Vllie et al (2005) propose a strong moderation effect of gender between perceptions of relative advantage, ease of use, visibility, and result demonstrability when using a computer-based communication technology. The curricular implications that would enhance the female IT experience were explored in relation to women's perceptions of the relative value of holistic skills prevalent in certain areas of Information Technology, such as Health Care and Informatics (Caputo, Kohun, 2005). Changes at this level tend to increase retention in the major as well as original matriculation among designated tracks within the general IT major.

Koch & Kayworth (2009) propose that the major factors of recruiting IS majors, retaining them throughout the undergraduate cycle, and placement upon graduation is the prescribed overall strategy that enhances female opportunities in the IT realm. Caputo (2010) studied the differences between male and female university students in the Computer Information Systems major as to the perceived value of the importance of technological skills necessary for job success in the prescribed discipline, and the acceptance of those criteria by the female student. Along similar lines, Guthrie (2009) argues that the success of women in the IT industry revolves around the critical support areas of mentoring women in the collegiate IT environment. Roach (2009) states that some important influences on the choice of computer majors were: a clear interest in technology, monetary compensation, and input from college instructors, and friends. Of primary importance to the selection of an IT major among women is, not surprisingly, personal and professional contacts and experiential connections. Thus emerge the core engagements of family members, key individuals such as high school teachers, professors, work associates, clergy, female mentors and role models, and on-line respondents (Heo, 2009).

A thorough review of available research in this area suggests an apparent gap in literature. This gap lies in addressing the profound issues determining low female enrollment in computing degrees and subsequent low representation of women in computing professions. The academic community's response to the issue of diversity on age, gender and ethnicity in Information Technology has not been addressed toward a meaningful conclusion (Moody & Woszczynski, 2003). Even though the situation is improving and the gender gap in attitude toward the usage of computers are lessening over an extended period (Rainier & Astone, 2003), this issue does require more careful investigation and proactive strategies for encouraging women in IT studies.

3. METHOLODOGY

Data collection

The methodology used for data collection for this research was a focus group encounter. An invitation was sent out to freshmen computer information systems (CIS) female majors at the site of this research, a medium size university in the northeastern United States. The first focus group gathering was sent out only to freshmen students (10) and 5 of these students participated. To avoid any factor of intimidation, a female professor in the department of information systems and another female researcher with a doctorate conducted the focus group in information systems. In the second meeting, senior IS majors were invited (8) out of which 4 participated. The same researchers who supervised the freshman meeting conducted the focus groups. Two senior male professors in information systems department conducted the third and the final focus group sessions. In this group, 5 students participated who were at sophomore or junior level in the program. Each of these sessions was of 45 minutes in duration. The sessions were recorded (audio) with the permission of the participants. Each participant was given the opportunity to respond to each question, as well as to interact conversationally within the group. Each focus group session was recorded and transcribed.

The researchers developed a list of pointers to gain a better understanding of the perception of female students in three areas. The perception of women concerning IT/IS degrees in general, the perception of women concerning IS/IT degrees at RMU, and the perception of women concerning success factors in an IS/IT career. The role of the faculty member was limited to ask a probing question whenever there was a general pause in the discussion. The participation in the focus group was voluntary; students were told the purpose of the research and only the students who chose to participate showed up on the particular day at the prescribed time. The results of these focus groups were summarized to identify the underlying themes. Considering the researcher is the instrument of data collection and analysis in qualitative methods such as focus groups, caution was exercised to include a researcher who does not teach at this university and has no contact with these students before and after the data collection. Also, the last focus group was deliberately conducted by male researchers to assess if the presence of any male member changes the dynamics of the focus group.

Data Analysis

Patterns within the focus group results were identified after tabulation of all major points emerging from the three participating groups. The results of the focus group are presented under the broad research questions that were used for the data collection process. Researchers were divided into three groups of two each. These groups transcribed the data and identified the themes individually. Then the research entire team came together to triangulate the themes that were identified and, after much deliberation and discussion, final themes under each research question were established.

Research question 1: Perceptions of women concerning an information technology/ information sciences degree

The women as a group perceive information technology to be a male-dominated field, but they all feel they have the necessary abilities to succeed in an information technology career. Some of the older students assumed gender bias in the career but did not take this issue seriously. The prospect of competing with males increased their desire to enter the field. Interestingly, many of those women who anticipated the competitive nature of the business had competed in athletics at the secondary education level.

When asked why they chose to major in CIS, several of the women indicated they were mentored by a family member or friend in the field. The family was the primary reason for major choice. In addition to encouragement from family, friends and teachers supported these students in their decision. Parental attitude articulated career success in the IT field and the opportunity for employment out of college.

Computer programming is a major part of the high school curriculum in IT. Interestingly, females were more attracted to the newer technologies in IT including web development, web design and cyber forensics that enticed them toward the college major. Computer programming had a negative effect on all of the participants in the focus groups. Somewhat surprisingly, all were adamant that they have no interest in a career in programming, and several indicated that they find programming to be very difficult. In addition, they expect to have many employment opportunities with good pay, and to "help people, not just languish behind a desk."

> "I would feel more useful if I wasn't programming. I know programming is a really good thing to do, and I guess you really are helping people, but it's really difficult. You have to pull things out of thin air, and there's always more than one way to do it… I did enjoy it because it was a nice challenge, but I don't think I want to do it for the rest of my life."

Many participants expressed a strong interest in the area of cyber forensics. The participants agreed that their common interest in cyber forensics most likely originated from television shows such as CSI, and that this sparked their desire to work in the technology field. One of the women made a point of acknowledging that the television representation is not entirely accurate:

> "I watch a lot of NCIS and Law and Order, so naturally, when I got here, I thought it would be a lot like that, and it's not. I learned that things are actually very different from what you see on TV."

All of the participants see technology as a rapidly growing field with many job possibilities, including mobile computing, and others and application development.

Several women mentioned that they feel challenged and unique by being a female in what is still considered a male-dominated major and career field. One woman said, "It puzzles me every day why I'm the only female in three out of my five classes." Only a few of the women had high school course experience with IS/IT. One of the women built a computer for her high school project, others mentioned having experience with HTML and Microsoft products (Office, Word, Excel).

In summary, teacher and counselor advice was less effective than advice from family and friends. In fact, most feel that counselors recommended other majors more female friendly like nursing and education. For many, the student's mother was the critical factor in their decision.

RQ2: What are the perceptions of women concerning IS/IT degrees at their current University?

These students had a positive perception of their current university from friends and family who were attending or who completed their studies at this institution. Pre-admission meetings with faculty and enrollment personnel were very encouraging when developing career prospects for women in the IT field.

One female student who was deciding on college entrance in the IT field at a local university was actually discouraged from the computer field. Their recommendation was to "study nursing." This attitude was never extended in any admission interviews at this institution. When asked why they choose to come to this institution, the respondents indicated that it offered "more" in the way of encouraging women in IS/IT degree programs. One woman said that this institution has the "best CIS department for encouraging women." Other reasons given included: 1) It is a small school and the advisors and teachers know the students by name and are available to answer questions about course material and give advice about career planning, 2) They often see "familiar faces" in different classes, and 3) their family members went to this institution. Two of the women transferred to this school specifically because of the technology curriculum options available here. Several women mentioned that the admissions departments at other schools seemed to discourage them from majoring in IS/IT and in many cases, nursing was suggested to them as an alternative. One woman was relieved to find that this institution encouraged her choice of majors:

> "When I came to [this institution to major in CIS], they almost jumped on me like, 'wow, you're a woman!' That helped me decide that [this institution] was right for me because when I looked at other schools, they almost told me NOT to go for it… as if saying 'you shouldn't be considering this [CIS]... you should be in nursing like all the other women"

Some of the new major areas in the IT field at this institution were also an attractive area for enrollment. New disciplines recently incorporated in the curriculum, such as cyber forensics, was an incentive for enrollment. For these participants, this institution offered the entire positive package for enrollment. From the matriculation process that encouraged women to enter the field and through the meetings with IT faculty, the computing major was welcoming and encouraging.

In summary, the perception of the institution being "women friendly" helped these students in making their decision. Additionally, the environment of collegiality and encouragement from fellow students, faculty and administrative offices reinforced their choice of the major.

RQ3: What are the perceptions of women concerning a successful career in IS/IT field?

When the women were asked what they believe is required to succeed in an IS/IT career, many mentioned determination and attention to detail as critical factors to success. These women had a positive perspective on their success in the IT field. Competing with males in the education setting gave them added incentive to welcome competition in the career field. They feel that their strengths, especially in their ability to communicate more effectively, work harder, and compete mentally with males were more than enough to succeed.

They also feel that women, in general, have better communication skills than their male counterparts, and that being a minority could work to their benefit. They feel they may have to work harder to prove themselves in their field, but they are willing to do so. All of the participants agreed that they prefer working with males because a) "girls are too catty" and b) they (the women) can easily become "one of the boys." Overall, the participants feel that they can not only work through the gender bias, but they can also use it to their advantage by offering a different perspective, and providing leadership and organization and relevant skills critical to team success. These women did have some difficult situations dealing with males in the classroom. They feel the males were condescending and many did show a bias against females. In order to achieve success the more advanced female students encouraged determination and aggressiveness in competing with the males.

While they all feel confident of their success in the IT fields and were not in any way hesitant because of their gender, they all prefer working with males rather than females. One participant cogently summarized the overall sentiments expressed by the focus group participants:

> "I think because women have the dream to do something, they're probably more likely to do something that's 'easy' or what society thinks they should be doing. If all my friends are nurses, I should probably be a nurse. But I don't think that should stop you, if you have other dreams that other people don't have, or if someone tells you that you shouldn't do something."

In summary, these women feel that even though IT is a male dominated field they did not seem worried about being successful in their chosen career. These women seemed determined, focused and well aware of challenges lying ahead in their chosen professional lives due to their gender, but they seemed well prepared to deal with these challenges.

4. DISCUSSION

Our data from focus groups suggests that women require more mentoring or close guidance from a person who can influence theory decisions about college majors. The chosen few who opt for a degree in computing are aware of valuable employment opportunities and believe that there are areas in computing that provide them with more opportunities to interact with people. Almost all of these women had previous experience in computing courses during their K-12 tenure. Research suggests that providing children with a range of computing activities when they are young will help encourage students to study (Camp, 2012). Girls have a limited perception of IT and computing fields, which needs to be broadened, and the best place to do this is schools. This fact is emphasized in the results of a 2005 survey. In this treatise, 836 high school students from nine schools in California and Arizona were asked what a computer scientist major might learn in college. Approximately 80% of the students in the survey said they have "no idea", and 15% of the students in the survey said "programming" (Carter, 2006). This suggests opportunities for educators or parents who want women to enter in computing fields. Several implications can be drawn from the results of our study. Educators need to encourage mentoring programs in universities or even at lower school levels to provide counseling and reassurance about women being a "fit" in the computing careers (see Table 1 in Appendix 1). The National Science Foundation has funded summer camps in computing that encourage female faculty members in IT to be role models to their students and leaders in academia. Many universities provide female faculty role models and mentors. Grants and scholarship programs promoting women are available through universities and organizations (Camp, 2012) (see Table 1 in Appendix). All the contributions of this study are represented as implications in Table 1 above. These contributions are for both theory and practitioners. This study suggests that positive impression of the university (due to past association or through friends and families) plays an important role for women in making a decision about her major. An admission department which encourages and answers women's queries about computing degrees is held in high regards compared to the ones that try to overwhelm students due to their interest in "unconventional" majors. There is a general agreement today about the low enrollment trend of women in computing degree programs, particularly at the undergraduate level. It is surprising as there is an overall rise in computing degree enrollments in the USA and increasing women population in colleges (Camp, 2012; Outlay et al, 2012). Computing degree programs have also recognized the need to overcome the perceptual barriers that keep women away from their programs and have undertaken intervention strategies to improve female enrollments (Outlay et al, 2012). Educators have to be creative in strategizing about recruiting and retaining women in computing programs. Some strategies that we suggest are to foster and nurture a positive reputation of encouraging women to pursue their major of choice, encourage faculty to be more interactive with women students and engage them through the process, to create specializations that appear holistic with more opportunities to interact socially, particularly in "cool" technologies such as cyber forensics, health care technology or technology auditing.

Finally, this study also accounts that women in computing degrees acknowledge the fact that it is a male dominated profession where they have to constantly prove themselves and improve themselves by being focused, determined and adaptable, in greater measures than their male counterparts. These findings imply that educators should encourage close alumni bonding such that women graduates can create support groups and initiate networks with other women in the field. The major limitation of this study is the bias that comes with single sources of data for research. All the participants were from one particular university and hence the results might not be representative of multiple perspectives. In future pursuits we need to collect data from different types of schools across the nation, and engage the perceptions of women who do not choose computing as a major.

5. CONCLUSIONS

This study explores the perception of women who choose to pursue a degree in computing and understand their view of information systems degrees, their current university status where they are pursuing a degree, and a theoretical understanding of career challenges in information systems studies. Three focus groups were conducted with women at different levels in undergraduate computing programs. The most prevalent and far-reaching results suggest that women need mentoring, close guidance, more exposure to computers in schools at an early stage and specializations that allow them to be more sociable. Implications were drawn and limitations presented. Future research stemming from this work is also discussed.

6. REFERENCES

Beyer, S. (2008). Gender Differences and Intra-Gender Differences amongst Management Information Systems Students, Journal of Information Systems Education, Vol. 19, No. 3, Fall, 2008

Bright, S. (2007). Where Have All the Young Geeks Gone. CIO Magazine Vol. 20, No. 15, May 2007.

Caputo, D. (2010). Gender Differences in Assessing Essential Business Information Systems Technology Skills, International Journal of Management and Information Systems, Vol. 14, No. 2, 2nd Quarter 2010

Caputo, D. and Kohun, F. (2002). Strategies for Enrollment, Retention and Integration of Women in a College Information Systems Major, Proceedings of the International Business and Economics Research Conference, Las Vegas, NV, October, 2002

Dattero, R. and Galup, S. 92005). Assessing Gender Differences in Software Developers using the Human Capital Model, Information Resources Management Journal, Vol. 18, No. 3, July 2005

Downey, J. and Roach, D. (2009). MIS versus Computer Science: An Empirical Comparison of the Influences on the Students' Choice of Major, Journal of Information Systems Education, Vol. 20, No. 3, Fall 2009

Freeman, L. and He, J. (2010) Are Men More Technology-Oriented than Women? The Role of Gender on the Development of Computer Self-Efficacy of College Students, Journal of Information Systems Education, Vol. 21, No. 2, 2010

Hayes, T. (2007). Women in Technology, TEQ Publications, Vol. 13, Issue 10, December 2007

Koch, H. and Kayworth, T. (2009). Partnering with the Majors: A Process Approach to Increasing IS Enrollment, Journal of Information Systems Education, Vol.20, No. 4, Winter 2009.

Kung, M. and Yang,S. (2006) The Changing Information Systems (IS) Curriculum: A Survey of Undergraduate Programs in the United States, Journal of Education for Business, Vol. 81, No. 6, July/August, 2006

McInerney, C. and DiDonato,N. (2008). Student's Choice of Information Technology Majors and Careers: A Qualitative Study, Information Technology Learning and Performance Journal, Vol. 24, No. 2, 2008

Moody, J. and Woszczynski, A. (2003). Diversity and the Information Technology Workforce: Barriers and Opportunities, Journal of Computer Information Systems, Vol. 43, No. 4, Summer 2003.

Rainier, R. and Astone, M. (2003). Are Gender Perceptions of Computing Changing Over Time?, Journal of Computer Information Systems, Vol. 43, No.4, Summer 2003

Shade, S. Woszczynski, A. A Call to IS Educators to Respond to the Voices of Women in Information Security, Journal of Information Systems Education, Vol. 21, Nol. 2, 2010

Turchek, J. Caputo, D. and Kovacs, P. (2007). Identifying Competencies for the IT Workforce: A Quantitative Study, Issues in Information Systems, Vol. 6, No. 1, 2007

V. Ilie, C. Van Slyke, G. Green. (2005). Gender Differences in Perceptions and Use of Communication Technologies: A Diffusion of Innovation Approach, Information Resources Management Journal, Vol. 18, No. 3, July 2005

Editor's Note:

This paper was selected for inclusion in the journal as a ISECON 2013 Distinguished Paper. The acceptance rate is typically 7% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2013.

Appendix 1

Table 1: Emergent Themes and Implications

Research Questions	Emergent Themes	Implications for Educators
Perceptions of women about an information technology/ information sciences degree?	Mentoring by a close person Good employment opportunities Identified areas that provide avenues for more socialization Preliminary exposure to IS/IT concepts in high school	Create and encourage mentoring programs Advertise better job opportunities Educate high and middle schools about IS/IT exposure at an early stage
Perception of women about IS/IT degrees at the current university?	Positive impression of the university due to family/friends Encourages women to follow their interest Small size of the department and classes More faculty interaction/intervention Promote exciting areas of specialization that makes the major look "cool"	Foster a positive reputation in alumni Emphasize and encourage women pursing degrees in technology Promote better interactive relationships between students and faculty Create interesting specialization options in IT with focus on women
Perception of women about success factors in IS/IT career?	Heavily Male dominated It is interesting to work with more men than women Determination and hard work as vital factor in competition with others Need to establish their "value" in the eyes of the others in the team	Encourage alumni bonding and networking Encourage support groups during and after the program Foster positive work ethics Females faculty needed to encourage by example

A Preliminary Comparison of Student and Professional Motivations for Choosing Information Systems

Nita Brooks
nita.brooks@mtsu.edu

Melinda Korzaan
melinda.korzaan@mtsu.edu

Computer Information Systems
Middle Tennessee State University
Murfreesboro, TN 37128, USA

Wendy Ceccucci
wendy.ceccucci@quinnipiac.edu
Computer Information Systems
Quinnipiac University
Hamden, CT 06518, USA

Abstract

Demand for qualified information systems professionals continues to rise. Additionally, over the past decade, enrollment in information systems-related educational programs has declined. In order to understand why and to better understand how to position information systems undergraduate programs to recruit and retain students, this study provides a preliminary examination of the motivations of undergraduate students in choosing information systems as their major. As part of the analysis, student motivations were directly compared to motivations of individuals currently in the profession. Results indicate that students are highly motivated by a general love of technology. Additional motivating factors included job security and gratifying work provided by the profession. These factors closely mirrored those of individuals in the profession, providing additional insight into opportunities for positioning IS programs and enhancing curriculum to highlight why students chose the major. Implications for future research, recruitment, and retention are provided.

Keywords: student motivation, IS undergraduate education, recruitment, retention

1. INTRODUCTION

Today, more so than at any other time, universities and colleges are facing unique pressures related to recruiting and retaining students. Competition is intense. The field of information systems is uniquely positioned to thrive in this environment due to demand for qualified professionals in the field (US Department of Labor, 2012); however, enrollments have declined greatly over the past decade (Lenox, Jesse, and Woratschek, 2012).

Research has been provided that examines everything from high school math and science scores as determinants of choice to major in a technology-related field to drivers for choosing majors once in a college or university environment (e.g. Wong, Fieldler, and Liu, 2007).

Additionally, it has been noted that there is evidence suggesting "a substantial gap between what the students are looking for in their future career paths and what they perceive to be attainable by choosing IS to be their major of study" (Wong, et al., 2007 p. 202). Because of this, we need to examine the idea of student motivation from a broader perspective. The approach taken in this research is to examine student motivations and compare them to motivations of individuals currently in the profession. To accomplish this task, we have collected preliminary data from traditional undergraduate students based on motivations from research presented in the IS literature (McKinney, Wilson, Brooks, O'Leary-Kelly, and Hardgrave, 2006). As a first step in meeting these goals, it was necessary to examine what we already know about student motivations for choosing information systems as a major.

2. LITERATURE REVIEW

Several studies across disciplines have examined student motivations in determining their choice of study. From these, a handful focused on IS-related programs. Our focus will be on the most recent studies as they provide a summary and foundation beyond what we can cover in this paper.

Wong, et al. (2007) used Schein's career anchors to examine perceptions of business majors related to their field of choice. The primary purpose was to determine if there was a difference in what students saw in their major and what they expected from the profession. Findings indicated that there was a difference between what they expect in a career and what the information systems major can provide to them.

Research has also shown that undergraduate business students are not as knowledgeable about information systems as a major when compared to other key business areas: management, marketing, accounting, and finance. Stated another way, students knew what the other majors represented more so than information systems. Students were surveyed in an entry-level business course and indicated "they are looking for majors that will be interesting, provide them with job security…and pay them well" (Walstrom, Schambach, Jones, and Crampton, 2008, p. 43).

Since we are examining information systems-related programs, we wanted to be sure and cover research related to other programs (e.g. computer science). In an article examining if there are differences between the student's choices of major in these two disciplines (information systems and computer science), it was found that the top motivators for both were interest in technology and financial compensation (Downey, McGaughey, and Roach, 2009). Interestingly, information systems students in the study were more concerned with perceptions of and desired more interaction with others when compared to computer science students.

In an effort to expand on what had been done related to student motivations, Ferratt, Hall, Prasad, and Wynn (2010) examined subject matter interests of information systems students. From this study we learned there is an interest in technical issues as well as linking business and technology. Additionally, it was found that students want to know the practical implications of the coursework – how does it prepare them for what they will be doing in the actual field of IS. The authors also provided a succinct summary of previous research that indicates students in IS are motivated by a general interest in technology, success in the area (self-efficacy), job prospects, and potential income.

More recent studies have continued to examine why individuals choose to major in information systems. Lenox, Jesse, and Woratschek (2012) noted that across the majority of studies in the area of motivation is the idea that students choose information systems, or conversely do not, due to certain perceptions. These included individual opinions of earning potential, self-efficacy, and the likelihood of earning a good salary.

The consistency seen across these various studies provides an interesting place to begin to examine the importance of such factors with a slightly different twist. Our goal is to take what we know about motivations of students in general and compare that to the motivations of individuals working in the field of IS.

In an effort to cover a broad range of issues, we chose to use the items provided by McKinney, et al. (2006) as a basis for our initial comparison with students. In this article, the authors are focusing on factors that might differ between males and females in information systems. As part of this comparison, a list of motivational items (provided by an extensive review of the literature) was given to the participants. These items were pulled from a variety of key resources (see Appendix 1 for summary). A discussion of how we used these items and compared them generally to students is provided in the proceeding section.

3. RESEARCH METHODOLOGY

Data for this preliminary study was collected as part of a larger study aimed at better understanding students' perceptions and attitudes related to information-systems related professions overall and to the major. Data was collected from one university in the Northeast United States.

Contact was initially made through course instructors in information systems-related programs. It was decided to include programs that were considered feeders to information systems jobs (computer science and information systems). Students were asked to respond to the survey related to their major of choice. The researchers determined it would be better, for this preliminary study, not to define the major or profession by using specific characteristics. We felt it was important for students to answer survey items related to what they perceived about their chosen major and subsequent choice of profession. Participation in the study was completely voluntary. A web-based survey was used to collect the data.

Overall, thirty students responded to this preliminary data collection. While this is a small sample, it provides insight into understanding motivating factors for students and provides a foundation on which to expand research and collect additional data from other institutions.

Measures for this preliminary study were pulled from previous research on motivation. Specific items used are provided in Appendix 1 along with original references for the items. All items were measured using a likert-type scale with a range of 1 – 7 (strongly disagree – strongly agree). The majority of the students in the sample were male (90%) and the average age was 20.3.

4. RESULTS

Table 1 provides information on the means of students' responses to the motivation items. The item found to motivate students the most in relation to choosing information systems as a major was the love of technology.

Motivation	Mean
Love of technology	5.77
Job security	5.57
Gratifying work	5.50
Level of income	5.28
Using state of the art equipment	5.20
Opportunity for task variety	5.03
Freedom in how work is done	4.97
Ease of entry	4.57
Flexible working hours	4.53
Prestige of IT	4.40

Table 1: Student Motivation Items Mean Responses

These results were then compared to the results of a survey given to professionals in the information systems field related to what motivated them (McKinney, et al., 2006). The mean results are provided in Table 2.

After comparing the results from both studies, it can be seen that four of the top five motivators are the same. For these groups of individuals, students and professionals, motivating items include job security provided by the profession, gratifying work, level of income, and a love of technology. Interestingly, the prestige associated with the profession or major was at the bottom of the list. Often it is expected that students pursue majors due to the importance of the major to referent others (e.g. parents). This finding indicates that the overall view of the field is not as important to this group of students as other factors. For students specifically, it appears that the love of technology drives their interest. For professionals, there is a continued importance of this factor, but it seems that issues related to income and job security take over. We can only speculate, but it would seem obvious that as individuals move into their careers, responsibilities increase (family, financial, etc.).

Motivation	Mean
Level of income	5.73
Job security	5.58
Gratifying work	5.50
Opportunity for task variety	5.44
Love of technology	5.18
Freedom in how work is done	5.13
Using state of the art equipment	4.63
Flexible working hours	4.63
Ease of entry	4.11
Prestige of IT	4.06

Table 2: Professional Motivation Items Mean Responses

5. DISCUSSION

The student pipeline needs to be maintained and managed to properly supply the needs of the profession. Information systems exist across all organizations, public and private, and serve to improve efficiency and effectiveness in countless ways. As such, researchers have maintained interest in understanding why students choose majors (Wong, et al. 2007, Butterfield and Crews, 2012). While this study is certainly exploratory in nature, we can begin to make important connections between what motivated students in choosing their major in information systems-related programs and what motivated individuals in the profession. This strengthens our ability to understand and foster the success of individuals entering undergraduate majors in information systems fields.

Additionally, this study helps those in higher education understand the potential for influencing students in major courses by adjusting the curriculum to focus on those items that are found to motivate students in the first place. This is especially impactful if the items motivating and driving students are the same as those that motivated individuals in the field. If we, as educators, can bridge these groups more directly, it provides the ability for students to feel they are part of the profession while in an undergraduate program. Accomplishing this would enhance and strengthen the student's identity with the profession.

In a related area, Mbuva (2011) focuses attention on the importance of retention in higher education in general. The fact that enrollments have been down for information systems only provides for a heightened reason to do whatever is possible to improve recruitment and retention of students. The fact that universities and colleges are facing expanding competition points to the realization that we must begin to more thoroughly understand the population in general.

As noted by Walstrom, et al., (2008), "it is important that program administrators examine their curriculum to assess whether it meets current needs and whether the intro course includes a focus on capturing youthful relevance, interest, and engagement" (p. 50). We would argue that it is not a "youthful relevance" that drives our students; it is a general love of technology and hope for a positive and prosperous future. There is an inherent value in the applicability of what is happening in the learning environment to the student and where he or she is headed in their actual job (Ferratt, et al., 2010). This brings about the question - how do we as educators foster this in our classrooms?

Based on the findings presented here, it is obvious that we should focus on integrating technology into the classroom. The love of technology is an important factor in the student choosing their major. By adding more technology components to the classroom, we could potentially enhance both recruitment and retention efforts. It is important that students have experiences with the systems and technologies we cover in our courses. While this is not always possible due to budget constraints, etc., we do have the opportunity to incorporate virtual environments using Internet tools as well as multimedia experiences.

Factors related to the profession in general (job security, gratifying work, and income) are not typically in control of educators; however, we are in control of what we communicate to our students. It is important that students have an accurate view of the profession and that they are aware of the opportunities the profession affords them. Potential avenues for accomplishing this include appropriately marketing the major and profession, highlighting current trends in the job market, honestly discussing opportunities in the field, fostering a connection with technology at many levels (not just programming), expanding the general perception of what an information system major or professional is, and building a solid foundation and reputation by successfully working with industry and placing students in beneficial roles. Granger, Dick, Jacobson, and Van Slyke (2007) summarized these issues into distinct approaches to addressing misconceptions of the field: 1) curriculum-oriented and modifications to courses and 2) marketing and promotional.

Additional research should be conducted to expand the motivation items to cover a larger group of students and a larger range of research on information systems professional motivations. It is also important to acknowledge limitations of this study related to the demographics and sample used. One university was targeted in this preliminary study in which 90% of the sample was male. As much of the research in this area focuses on not just understanding what we know about students' major choice but also on the gender differences in information systems-related fields (e.g. Butterfield and Crews, 2012), it is important to have a more diverse sample of students.

Furthermore, since the love of technology was indicated as the top reason students are motivated to major in the field of information systems, additional research should include a more detailed investigation into the type(s) of technology that motivate students. For example, when students think of their love of technology what types of technology are they considering and do they have different reactions to different types of technology? Specifically, do students "love" hardware, software, specific applications, such as social media, programming, systems, etc.?

6. CONCLUSION

An interesting realization from this study, as noted in the literature review section, is the fact that the factors motivating individuals in an IS-related major or in an IS position in the profession mirror factors that non-IS students say keep them from majoring in information systems-related fields in other studies. This points to a major discrepancy in the perceptions of students. It seems that if you are already in the field, you recognize these factors as being positive defining characteristics. If you did not choose information systems as your major or profession, it is these very factors that are cited as the reason keeping you from the field altogether. Research should explore potential reasons for this difference. Aside from the obvious motivations, such as "love of technology", the other factors could easily translate to other fields. A deeper exploration into students' personality traits, motivations for entering higher education, and factors that drove the choice of major would potentially help clarify the differences.

In an examination of why enrollments have been down in information systems, Granger, et al., (2007) note that the lack of jobs, outsourcing, debate related to H1-B visas, low salaries, and a perception of a useless IS degree are the myths keeping the field from growing at the needed rate. Findings from this study indicate that conceptualizations related to opportunities and salaries in IS are in fact myths. Individuals in the profession noted that these are motivators – key reasons for the choice of information systems. Therefore, students are likely not informed that these are myths and unaware of the opportunities available in the field of information systems. Future research would be beneficial to explore in more detail student perceptions related to these myths and investigate whether these myths continue to be dominant factors in dissuading students from majoring in IS, or whether other factors are having a more significant impact such as the potential negative social image associated with technology degrees or students not believing they have the aptitude for the degree (Kumar and Kumar, 2013).

While the authors recognize that individuals will tend to view factors that potentially define their identity as more favorable, it is interesting that the "facts" can be interpreted so differently. Previous research and statistics from the Bureau of Labor Statistics support the fact that information systems jobs are among the most desired and well paid – two of the top five motivators for students and professionals. This misconception is precisely what provides the information systems discipline a great opportunity.

Any chance to understand our students at a deeper level assists in creating a productive and supportive learning environment. Through this examination of general motivating items of students that chose IS-related majors, we can begin to change our classrooms to provide a richer educational experience.

7. REFERENCES

Butterfield, H. and Crews, T. (2012). Casting a wider net: A longitudinal study exploring gender differences, influences and attitudes impacting academic major selection in computing. *Computer and Information Science*, 5(2), 2-10.

Downey, J.P., McGaughey, R., and Roach, D. (2009). MIS versus computer science: An empirical comparison of the influences on the students' choice of major. *Journal of Information Systems Education*, 20(3), 357-368.

Granger, M.J., Dick, G., Jacobson, C.M., and VanSlyke, C. (2007). Information systems enrollments: Challenges and strategies. *Journal of Information Systems Education*, 18(3), 81-84.

Ferratt, T.W., Hall, S.R., Prasad, J., and Wynn, D. (2010). Choosing management information systems as a major: Understanding smifactors for MIS. *Communications of the AIS*, 27(1), 265-284.

Kumar, A. & Kumar, P. (2013). An examination of factors influencing students selection of business majors using TRA framework. *Decision Sciences*, 11(1), p. 77-105.

Lacy, W.B., Bokemeier, J.L., and Shepard, J.M. (1983). Job attribute preferences and work commitment of men and women in the United States. *Personnel Psychology*, 36(2), 315-329.

Lenox, T.L., Jesse, G., and Woratschek, C.R. (2012). Factors influencing students' decisions to major in a computer-related discipline. *Information Systems Education Journal*, 10(6), 63-71.

McKinney, V.R., Wilson, D.D., Brooks, N.G., O'Leary-Kelly, A., and Hardgrave, B. (2008). Women and men in the IT profession. *Communications of the ACM*, 51(2), 81-84.

McLean, E.R., Smits, S.J., and Tanner, J.R. (1991). Managing new MIS professionals. *Information and Management*, 20(4),, 257-263.

Mbuva, J.M. (2011). An examination of student retention and student success in high school, college, and university. *Journal of Higher Education Theory and Practice*, 11(4), 92-101.

Schambach, T.P. and Chrisman, C. (1997). What motivates today's information systems graduates? *International Academy for Information Management Annual Conference*, retrieved from http://www.editlib.org/p/87281.

Shipp, V.H. (1999). Factors influencing the career choices of African American collegians: Implications for minority teacher recruitment. *Journal of Negro Education*, 68(3), 343-351.

U.S. Department of Labor, U.S Bureau of Labor Statistics. (2012, Spring). *Occupational Outlook Quarterly: The 2010 – 20 job outlook in brief*, *56* (1). Retrieved from http://www.bls.gov/opub/ooq/2012/spring/spring2012ooq.pdf

Walstrom, K.A., Schambach, T.P., Jones, K.T., and Crampton, W.J. (2008). Why are students not majoring in information systems? *Journal of Information Systems Education*, 19(1), 43-54.

Wentling, R.M. and Thomas, S.P. (2009). Workplace culture that hinders and assists the career development of women in information technology. *Information Technology, Learning, and Performance Journal*, 25(1), 25-43.

Wong, R.M., Fiedler, A.M, and Liu, C. (2007). Exploring the motivation of students in choosing information systems as their major. *Issues in Information Systems*, 8(1), 198-203.

Zawacki, R.A., Scott, D.K., and Zawacki, P.A. (1988). How college students choose IS careers. *Datamation*, September, 406.

Appendix

Survey items were adapted directly from previous research.

Survey Item	Original Item if Changed	Source
Level of income	Above average income	Schambach and Chrisman, 1997; Shipp, 1999.
Freedom in how work is done	Autonomy	McLean, Smits, and Tanner, 1991
Opportunities for task variety	Changing work environment / new challenges	McLean, Smits, and Tanner, 1991
Ease of entry into the IT profession	Ease of entry	Shipp, 1999
Gratifying work		McLean, Smits, and Tanner, 1991; Schambach and Chrisman, 1997; Zawacki, Scott, and Zawacki, 1988
Job security		McLean, Smits, and Tanner, 1991; Schambach and Chrisman, 1997; Zawacki, Scott, and Zawacki, 1988
Love of technology / computers		Breidenbach, 1997
Prestige of the IT profession	Prestige	Shipp, 1999
Using state of the art equipment		McLean, Smits, and Tanner, 1991
Flexible working hours	Working hours / flexibility	Lacy, Bokemeier, and Shepard, 1983

Reflections on Teaching App Inventor for Non-Beginner Programmers: Issues, Challenges and Opportunities

Andrey Soares
asoares@siu.edu

Information Systems Technologies
Southern Illinois University
Carbondale, IL 62901, USA

Abstract

App Inventor has been used successfully to teach introduction to programming course for CS/IS/IT and Non-CS majors. Now, researchers are looking on how to include the tool in the curriculum of more advanced computing courses. This paper presents some Issues, Challenges and Opportunities observed while teaching courses on Mobile Application Development with App Inventor. In particular, this paper discusses the following topics that instructors should take into consideration when designing their courses with App Inventor: Pre-Requisite for the course, Visual vs. Textual Programming, Planning and Designing Apps, the use of Web Services, students new to Event-driven programming, the use of database and SQL, Lists, designing User Interfaces, discussing Data communications, and the Use versus the Creation of objects. The paper shows that App Inventor has great potential to be used for teaching more advanced computing concepts. For some of the topics, students may be required to have more than just basic programming skills.

Keywords: App Inventor, Mobile Applications, Non-Beginners, Programmers

1. INTRODUCTION

Since its release in 2010, App Inventor has been used as a teaching tool in many schools and universities. It seems that a common use of the tool is for teaching introduction to programming skills for (1) middle and high school students, (2) for beginners in Computer Science, Information Systems or Information Technology (CS/IS/IT) or other related technical majors, and (3) for non-CS/IS/IT students. In fact, App Inventor has been advertised as a tool that you can create your own Apps with no programming experience required (Tyler, 2011; Wolber, Abelson, Spertus, & Looney, 2011). The tool has also been used in a variety of educational events and formats from a few days of workshops and summer camps to semester-long courses. We can see an increasing number of publications reporting the success of using the tool for teaching as well as for recruitment and retention efforts.

In the Fall of 2011, I was exploring some websites in search of apps created with App Inventor. After checking several apps, I started wondering if students that are new to programming are creating such interesting apps, what could be created if they already have programming experience. Since then, I have created and offered face-to-face and online courses on App Development using App Inventor where the pre-requisite for the course is an introduction to programming course.

Many of the apps created by the students are available online through their personal web pages or the web pages of their course or instructor. Recently, the MIT Center for Mobile Learning has made available the App Inventor Community Gallery, an open-source repository of apps created with App Inventor (http://gallery.appinventor.mit.edu).

In this paper, I discuss issues, challenges and opportunities observed while teaching the course at a Midwest University. The discussions represent my experiences and observations of class activities and informal conversations with students.

2. BACKGROUND

App Inventor for Non-Beginners

App Inventor is a visual programming language developed by Google in 2010 and currently hosted and maintained by the MIT Center for Mobile Learning. It has been successfully used to teach introductory computer science concepts (CS0) and introduction to programming (CS1) skills for students in CS and Non-CS majors. In fact, not only CS but also the fields of Information Technology (IT) and Information Systems (IS) are using similar approaches. It is possible to see the terms CS0, IS0 and IT0 used interchangeably (Uludag, Karakus, & Turner, 2011) as well as the terms CS1, IS1 and IT1 (Lim, Hosack, & Vogt, 2010).

Professor David Wolber, from the Computer Science Department at the University of San Francisco, has created a set of course materials that can be used to teach introductory CS concepts for Non-CS majors (CS0 course) and can be adapted to teach CS majors (CS1 course). Dr. Wolber's Course-in-a-Box materials (www.appinventor.org/course-in-a-box) includes modules on Introduction to Event-Driven Apps, Games, Text/Location and other Mobile Technology, Data, Shared Data, Apps that Access Web Data, and Software Engineering and Procedural Abstraction. Similar materials are needed to support the teaching of more advanced computing and programming concepts for non-beginners.

Gestwicki & Ahmad (2011) suggest that App Inventor and their Studio-Based Learning approach can be used not only to "introduce non-CS majors to concepts of Computer Science-not just programming, but also ideas that tend not to be covered in conventional CS1 courses such as human-computer interaction, incremental and iterative design processes, collaboration, evaluation, and quality assurance" (p. 55).

Karakus, Uludag, Guler, Turner, & Ugur (2012) also argue that App Inventor can be used in CS2 courses for computing majors. In particular, they contend that in a CS2 course "the emphasis is shifted more to the inner details of programming constructs, such as control structures, iteration, functions, recursion, algorithms, decision making, some basic data structures, etc." (p. 5). In addition, they consider that Robotics, Software engineering, Information Systems, and Networking, Database and Web Development courses could incorporate App Inventor into their curriculum. Arachchilage, Love, & Scott (2012), for instance, have demonstrated the use of App Inventor to create a mobile game to teach users about conceptual knowledge of avoiding phishing attacks, which is a form of online identity theft.

The MIT Center for Mobile Learning at the MIT Media Lab hosts the Annual App Inventor Summit, an event designed for educators and experienced users of App Inventor. In the 2012 App Inventor Summit, a working group discussed the role of App Inventor in CS/IS Education and its use in more advanced courses.

This paper is a contribution to the discussion of using App Inventor beyond the CS1/IS1/IT1 courses where students have taken additional programming or other related technical courses such as object-oriented programming, web development, database design, and software engineering.

The Course

The course was designed to allow the students to explore the features of Android phones by using App Inventor components, rather than being another elective programming course. So, the pre-requisite for registering to the course is to have taken some introduction to programming course where students would have been exposed to basic programming concepts, including logic, conditions, loop, variables, procedures, input and output. Nonetheless, senior students would more likely have already taken other upper division courses such as Web programming, Object-Oriented Programming, and Software Engineering. The visual approach of App Inventor would help students not to focus on programming and the syntax of coding.

Instead, they would concentrate more on the logic and events of the application.

The course uses the book *App Inventor: Create Your Own Android Apps* (Wolber et al., 2011) as reference. The book is available online in PDF format at www.appinventor.org/projects. The course starts by covering topics from the book, and then new topics are added or removed as needed to augment the students learning experience. Because of the required prerequisite for the course, the topics on fundamentals of programming are not covered in details. See some resources for instructors in the Appendix.

3. ISSUES, CHALLENGES AND OPPORTUNITIES

Teaching App Inventor for students with previous programming experience presents some challenges that instructors should take into consideration when designing their courses. Several assignments completed in class have provided great insights on using App Inventor to teach not only programming but also other computing concepts. Following is a list (in no particular order) of Issues, Challenges and Opportunities observed while teaching App Development with App Inventor for non-beginner programmers.

Pre-Requisite

The pre-requisite for the course is some Introduction to Programming course. The rationale is that the time used for teaching logic and the fundamentals of programming could be used to explore more features of the phone and the App Inventor tool. With this approach, students would just adapt their programming skills to the new environment; and the instructor would just show how things are done within the new environment.

While all the students have taken a programming course prior to the course with App Inventor, the level of programming skills may vary from student to student. On one hand, students may still be new to programming as they have taken the introduction to programming course in the semester prior to the App development course. In some cases, the last (or the only) programming course was taken between one and two years ago. On the other hand, students may be more experienced programmers as they have taken more courses in the area of application development and programming such as Object-Oriented programming, Client-Side and Server-Side Web Development, and Software Engineering.

The range of programming skills (or lack thereof) has posed as a challenge for the instructor to design and implement course assignments, especially in terms of difficulty level and time for completion. For instance, an assignment that uses lists should be fairly easy for students that have experience working with arrays, but it could be considered difficult for students that are seen the concept of lists for the first time, which would be the case when the concept of arrays is not covered in introduction to programming courses.

Visual vs. Textual Programming

When students are used to write textual source code, the change to a visual programming environment may be sometimes challenging, especially when they cannot see the source code. With App Inventor, a developer creates an application by putting blocks together like a puzzle.

Figure 1 and Figure 2 show examples of a code that handles the event of a button being clicked by the user on the screen. The visual code sample (Figure 1) was created with App Inventor and the textual code sample (Figure 2) was created with Eclipse and Android SDK.

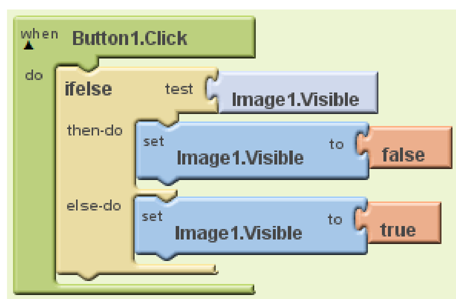

Figure 1: Visual Code for handling the event of a button clicked

```
Button1.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        if(Image1.isShown()) {
            Image1.setVisibility(ImageView.INVISIBLE);
        }
        else {
            Image1.setVisibility(ImageView.VISIBLE);
        }
    }
});
```

Figure 2: Textual Code for handling the event of a button clicked

In Figure 1, when the object *Button1* is clicked, the system generates an event called *Click* that checks the property *Visible* of the object *Image1* (i.e., Image.Visible). If the value is true, the system changes the content of the property *Visible* to false, which results on hiding the image. If the value is false, the system changes the property *Visible* to true, which will make the image to show.

Students usually comment that they like the blocks because they don't get stuck reviewing code for missing semi-colon, braces or for misspelled code. In fact, the goal for bringing App Inventor to class was to reduce some of these distractions with coding and to allow students to concentrate more on the functionalities of the application and what can be done with the phone.

Nevertheless, students with more programming experience would state that they knew what they want to do and they probably could write the textual code to get it done but somehow they struggled to put the blocks together. Finding the appropriate blocks to use has also been an issue for students with little programming experience. Every time the course is taught, maybe out of curiosity or frustration, at least one student would demonstrate interest in learning how to create the applications in Java. This would be a great opportunity to introduce the *App Inventor Java Bridge*, a library that allows integrating App Inventor components into apps created in Java and Android SDK (https://code.google.com/p/apptomarket).

Planning and Designing Apps

Programming and application development courses are a great opportunities to introduce and teach software engineering principles to students. After all, mobile apps are software. Planning and designing are often explored in most programming courses. The more programming courses students take, the more they understand the need to carefully plan and design an application before writing any code. New or less experienced programmers have a tendency to skip the planning and designing steps and they would go straight into the implementation.

Although App Inventor has a Designer screen that developers can use to build and view the app screens, it still poses some challenges for students to achieve the desired layout for their apps. More often than not students start the planning and designing of an app by building the application screens directly with App Inventor. When the application involves more elaborated screens, it usually ends with the developer switching to a paper and pencil design approach, or with the developer being stuck building complex screens and leaving the planning of the app behind.

Visual tools such as the Balsamiq Mockups (http://www.balsamiq.com) can help students to quickly design mockup screens for their apps. Designing the screens will force the students to think not only about the components but also about the underlying events, functions and blocks that need to be used to achieve the desired results. It will also help students to decide how to use screen arrangements to create the layouts they want. For example, Figure 3 shows a mockup screen for adding a new item for a Grocery List app (Figure 3, left) and the complete screen implemented with App Inventor (Figure 3, right).

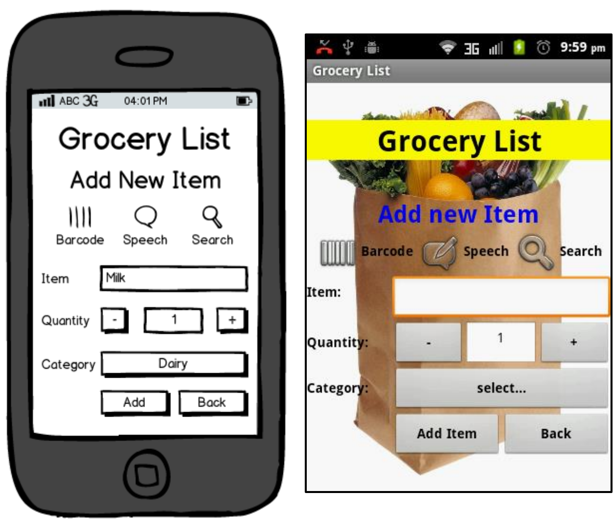

Figure 3: Mockup screens for App design

By generating the mockup screens, students can play with the screens before committing to the implementation of an app. For the Grocery List App, students should identify the need to use buttons to start the *BarcodeScanner*, *SpeechRecoginzer*, and *ActivityStarter* components. To provide a list of existing grocery categories, the developer will need the component *ListPicker* to be populated with all categories. The *ListPicker* component works like a drop-down list where the user can select an item from. Developers should also understand that after the user clicks the button "Add", the information about the new grocery item should be stored into a Web database, which can be implemented with the component Tiny*WebDB*. The button "Back" would require the developer to hide the current "Add New Item" screen and to show the "Main Menu" screen. Finally, to obtain the layout presented in Figure 3, the developer must understand how the components *VerticalArrangement* and *HorizontalArrangement* can be used to organize the buttons and textboxes on the screen.

Web Services

While students get excited about creating applications to run on their phones, they have also demonstrated great interest in learning how to create apps that can be integrated with other phones and with data from a variety of online sources (ex: weather, sports, maps, etc.).

For some students, working with web services raises concerns with privacy, security, and availability regarding the data and the service. For instance, the component Tiny*WebDB* let us store data into a Web database that is accessible through a web service. App Inventor uses http://appinvtinywebdb.appspot.com as the default service. As a demo service, it stores only 250 entries into the database. Any entries beyond that will force the oldest entries to be deleted. In addition, the tags stored are not protected and can be easily accessed and overwritten. However, developers can create their own services and apply any protection they need, or they can use alternative services.

The website www.programmableweb.com lists thousands of Web APIs that could be incorporated into the apps. Several APIs are free and just require registration to obtain an API Key to access the service. Depending on the type of Web services, the results of the requests may be in different formats, such as XML (Extensible Markup Language) and JSON (JavaScript Object Notation), which will require the students to learn how to parse the messages. The component *Web* in App Inventor has a block called *JsonTextDecode* that transforms JSON text into lists, which makes it easier to manipulate data as App Inventor has several blocks to handle lists. For XML, however, developers need to create the code to parse the XML text. Figure 4 shows a sample of the *wind* information, in XML and JSON formats, from the Yahoo! Weather Forecast.

Another valuable resource is the Yahoo! Query Language (YQL), a SQL-like language that can be used to query data tables from a variety of web services (http://developer.yahoo.com/yql). Some YQL tables are free and can be accessed directly, while other tables require a Yahoo! login or an API Key to access the data. For example, the YQL statement `select * from weather.forecast where woeid = 2379574` would result in information about the weather (ex: temperature, wind speed, etc.) for the `woeid = 2379574` (Chicago, IL). The WOEID (Where On Earth ID) is a unique identifier provided by Yahoo! GeoPlanet.

XML

```
 <yweather:wind
xmlns:yweather="http://xml.weather.yahoo.com
/ns/rss/1.0"
chill="66" direction="120" speed="5"/>
```

JSON

```
"wind": {
     "chill": "66",
     "direction": "120",
     "speed": "5"
}
```

Figure 4: Sample XML and JSON results for wind information

New to Event-driven programming

The events in App Inventor that can trigger activities on the phone fall into the following categories (Wolber et al., 2011, p. 223):

- User-initiated event (ex: User clicks a button)
- Initialization event (ex: App starts)
- Timer event (ex: 50 milliseconds passes)
- Animation event (ex: object collide with another object
- External Event (ex: phone receives a phone call)

Figure 5 shows an example of a series of events related to the process of taking a picture with the camera from a phone and showing the picture on the screen. When the object *Button1* is clicked the system generates the event *Click*. Then, the system starts the camera on the phone by calling the procedure *TakePicture*. When the camera application is open, the user can take a picture and click a button (e.g., Ok or Done) to confirm it. This will generate another event called *AfterPicture* that will handle the information about the picture. The procedure *AfterPicture* receives an argument called *image* that is the address of the picture within the phone (e.g., SD Card). Finally, the picture address available through the parameter *image* is used to set the property *Picture* of the component *Image1*.

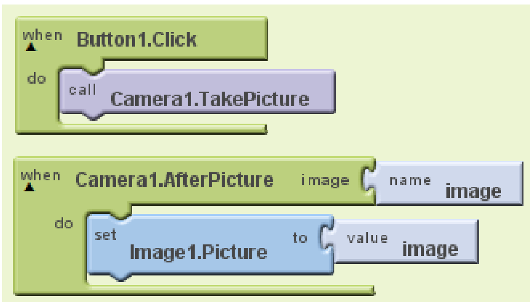

Figure 5: Taking and Showing a picture

Although events can be explored in different programming courses, they are more noticeable when students are learning to program Graphical Unit Interface (GUI) and they have to deal with a variety of graphical components and event listeners. In Java, for example, an *ActionListener* is triggered when a user performs certain actions such as clicking on a button or choosing a menu option. As GUI programming may not be covered in introduction to programming courses, students that are not familiar with these concepts may experience some difficulty identifying all the necessary events for their apps. It might be possible to see students omitting events or trying to handle an event inside another event. For instance, some students might try to set the property *Picture* of the object *Image1* within the event *Button1.Click* (Figure 6), instead of using the event *AfterPicture* as shown in Figure 5. To change the object *Image1* with the picture taken from the camera, the system will need the parameter *image* created by the event *AfterPicture*.

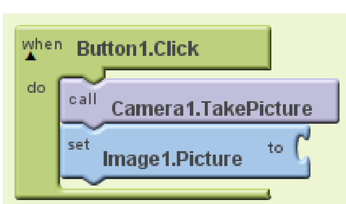

Figure 6: Incorrect event handling

Database and SQL

App Inventor has two main components that can be used to store data. The *TinyDB* stores data to the device's long-term memory, and the *TinyWebDB* stores data to a Web database that is available through a Web service provider. Although these components are relatively easy for students to understand and work with data persistency, they are limited databases. Nonetheless, *TinyWebDB* could be used to access a data source API written in PHP or other languages. More experienced programmers could implement their own services to respond to *TinyWebDB* requests.

An alternative component to be used for data persistence is the *FusiontablesControl*, which is a non-visible component that communicates with Google Fusion Tables (experimental). The component requires an API key to send SQL queries to the server and to receive the query results. The query results are in CSV or JSON formats and can be transformed into lists with the appropriate blocks in App Inventor.

The Fusiontables SQL queries can be used to handle data from tables with INSERT, UPDATE, DELETE and SELECT commands. The use of SQL queries and rapid user interface design can provide a great opportunity for using App Inventor in Database courses. However, students may be required to have prior experience at least with fundamentals of database design and SQL to implement Fusiontables into their apps. In particular, students should learn about the implicit ROWID column, which is the identifier for the row of a table. The ROWID is required to perform INSERT, UPDATE and DELETE statements and can be obtained through a SELECT statement.

Lists and List of Lists

The concepts of Lists, and Lists of Lists are similar to what other computer languages call arrays and multi-dimensional arrays, respectively. These are typically not easy concepts to grasp for a student that is seen it for the first time. Even students that are already familiar with the concepts of arrays may need a period of adjustments to translate and adapt their prior knowledge with arrays into the new environment. The level of programming and the experience with other languages, such as PHP, may be a contributing factor to help with this transition. For instance, students may be familiar with languages that allow using different data types within a list, creating an array without specifying the size prior to using it, or omitting data types for the variables created.

Figure 7 shows a sample of a static List of Lists that is created and populated by the developer. In this example, the list called Employees has two items. Each item is a sub-list with information about an employee (e.g., name and age).

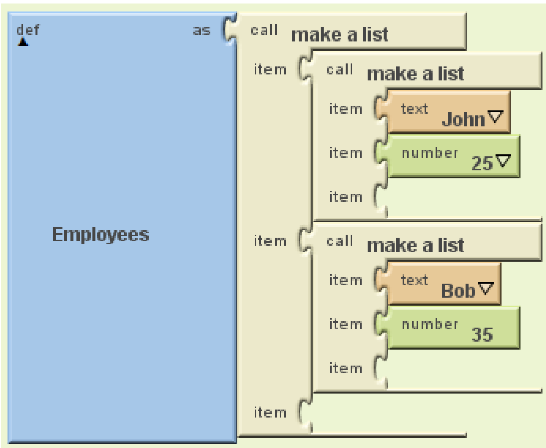

Figure 7: A sample List of Lists

Figure 8 shows the blocks needed to select the second item (35) of the second employee (Bob) from the list of Employees.

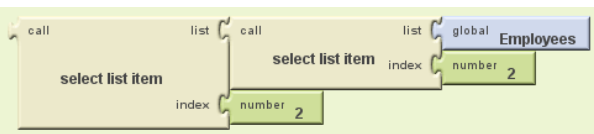

Figure 8: Selecting Bob's age

The visual approach of App Inventor makes it easier for students to understand and create static lists as they can visually see the structure of the list. However, the use of dynamic lists is still intimidating. As lists are used quite often in course assignments, learning or reviewing these concepts during the course would help students to better implement lists to their apps.

User Interface

As applications usually involve some sort of interaction with the user, students are forced to think about the user's experience with the app being created. This is a great opportunity for students to bring their own (good and bad) experiences using mobile applications to design the layout and behavior of their future apps. For example, it is very common to see students discussing about defining the size and color of components to improve readability, notifying the user about whether an operation was successfully completed, or validating users' input to not allow phony data into the system. In addition, students take into consideration usability during the planning and designing of their apps.

Many apps will require multiple screens to organize the application and to help the user to navigate through its different functionalities. Students can create multiple screens by using the button "Add Screen" in the App Inventor environment or by creating screen arrangements to act as screens. The arrangements can be hidden or displayed to create the illusion of working with multiple screens.

While the first option would be preferred, it still has restrictions, regarding the definition of variables and procedures, that seem to influence the students' decision to adopt it. As each screen has its own components and blocks editor, the components, variables and procedures created for one screen are not available to other screens. For example, if a procedure responsible to perform some calculations in Screen1 is needed inside Screen2, the developer will need to re-create the procedure inside the Screen2 as the first procedure cannot be accessed from another screen. In addition, if the blocks of a screen need to change a component in another screen, the developer will need to pass parameters between the screens or use *TinyDB* to store the data to be used by the other screens. Copying blocks between screens is not yet supported by the current version of App Inventor. On a positive note, the use of multiple screens (not arrangements) will force the students to carefully plan their apps and how the screens will communicate with each other.

Data communication

A class project that used Bluetooth to create a simple game of tic-tac-toe, helped with a discussion on the use of special messages, protocols to communicate with paired phones, and the roles of client and server. The discussion also helped students to use Bluetooth communication with codified messages to create other games (e.g., Checkers).

Figure 9 shows an example of exchanging messages with the Bluetooth Chat app. These messages can be the start point of a discussion on the content and format of the messages as well as how to exchange more elaborated messages.

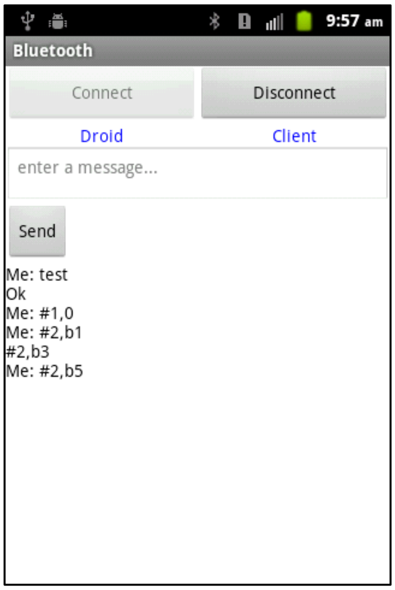

Figure 9: Bluetooth Chat, From text to codified messages

In a Bluetooth Tic-Tac-Toe game, for example, a message `#1,O` could be used to inform that a player is inviting another player to play. The capital `O` means that the user chooses to play with the symbol `O` instead of `X`. When the symbols representing the players are selected, both systems set the variables *Me* and *You* with the respective symbols. These variables can be used to display the symbols above the game board. The role of the Bluetooth connection (i.e., client or server) can be used to define the symbols. The game has a setup screen where the user can select his or her preferred symbol. However, the player with the role of a Server will have priority on the symbol selection.

A message `#2,b1` could be used to inform that the player has clicked on one of the buttons of the game board. Other codified messages can be added to improve the user's experience with the app. For example, when a match is over, the system could ask if the player wants to play again and send a message with the user's response to the other player (e.g., `#3,Y`). If the user decides to disconnect, the system could automatically send a message `#4,end` when the button *Disconnect* is clicked, which would inform the other player they are no longer playing the game.

With that in mind, students can create a Tic-Tac-Toe board by adding new components to the existing Bluetooth Chat layout, and using the messages received to interact with the game and change the board accordingly (Figure 10).

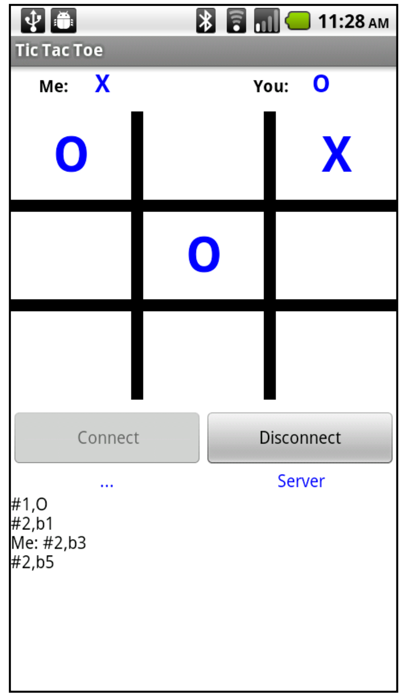

Figure 10: Tic-Tac-Toe with Bluetooth

The game board is composed of 9 buttons (*b1* to *b9*) that are organized with a table screen arrangement to provide the expected layout. The first row has buttons *b1* (top left corner), followed by the button *b2* (top middle) and button *b3* (top right corner). The middle row has buttons *b4*, *b5* and *b6* (from left to right). The bottom row has buttons *b7*, *b8* and *b9* (from left to right). The layout also has several labels that are used to design the vertical and horizontal lines of the board. To get the effect of a thick line, the student can remove the text of a label and set the background color to black.

In this example, receiving the message `#2,b1` would force the system to set the text of button *b1* (top-left button) with the letter O, which is the symbol of the other player. Similarly, if the player clicks the button *b3*, the system will set the text of button *b3* with `X` (i.e., the player's symbol), and will send a message `#2,b3` to the other player so that his or her phone can update the screen with the new game move.

Using versus Creating objects
Students that are used to object-oriented programming may find an issue related to using versus creating objects. For example, it is

possible to create a new instance of a button by dragging it to the screen. After that, all the properties and pre-defined procedures for a button component are available (see Figure 11). However, it is not yet possible for developers to create their own classes of objects with attributes and procedures, such as, a class of enemies for a game.

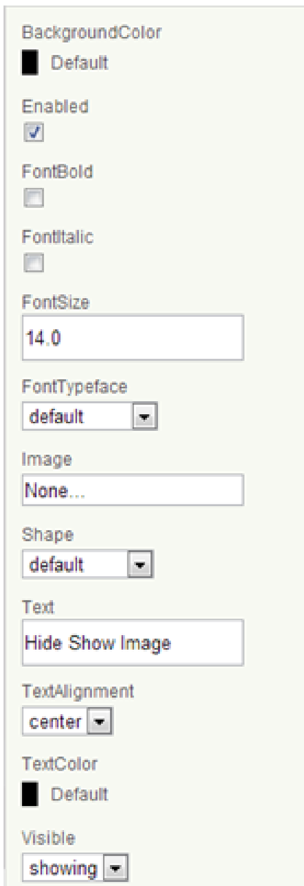

Figure 11: Properties of a component Button

While writing code using only general procedures doesn't seem a concern to complete the assignments, keeping the students' mind from thinking in terms of object-oriented programming may be challenging, especially when they want to organize, reuse and protect their code.

4. CONCLUSION

This paper discussed issues, challenges and opportunities that instructors should take into consideration when designing their courses with App Inventor:

- Pre-Requisite for the course
- Visual vs. Textual Programming
- Planning and Designing Apps
- The use of Web Services
- Event-driven programming
- The use of database and SQL
- Lists
- Designing User Interfaces
- Discussing Data communications
- Using versus Creating objects

Even though App Inventor has been used and advertised as a tool for teaching basic programming skills, it has great potential to be used for teaching students that already have programming experience. Despite programming not being required, some App Inventor components require a great deal of computing skills such as SQL and database design.

App Inventor has the potential to be included in the curriculum of other courses where students could take a basic course on App Development early in their curriculum and then more advanced courses would use the tool to explore the concepts and topics to be covered in class. For instance, in a Software Engineering course, students could use the tool to help with requirements and interface design. For more advanced programming courses, students could use App Inventor Java Bridge to write code and integrate it with App Inventor, which could help to overcome the limitation of programming in an object-oriented style and working collaboratively to create applications.

In sum, App Inventor can be explored beyond introductory programming courses for novices. However, instructors should be aware of potential issues and challenges related to the required pre-requisite for the course and the students' prior experience with programming and other computing skills. In terms of opportunities, instructors could explore the use of App Inventor to cover a variety of computing concepts such as:

- Application development life cycle
- Web Services and Distributed computing
- Information Assurance and Security
- Software Engineering
- Data communication
- Database Design

5. ACKNOWLEDGMENTS

The author is grateful to State Farm® for supporting this project through the *2011 State*

Farm Technology Grant, which was partially used to acquire Android devices for class instructions.

6. REFERENCES

Arachchilage, N. A. G., Love, S., & Scott, M. (2012). Designing a Mobile Game to Teach Conceptual Knowledge of Avoiding "Phishing Attacks". *International Journal for e-Learning Security, 2*(2), 127-132.

Gestwicki, P., & Ahmad, K. (2011). App inventor for Android with studio-based learning. *J. Comput. Sci. Coll., 27*(1), 55-63.

Karakus, M., Uludag, S., Guler, E., Turner, S. W., & Ugur, A. (2012, 21-23 June 2012). *Teaching computing and programming fundamentals via App Inventor for Android.* Paper presented at the Information Technology Based Higher Education and Training (ITHET), 2012 International Conference on.

Lim, B. L., Hosack, B., & Vogt, P. (2010). *A web service-oriented approach to teaching CS/IS1*. Paper presented at the Proceedings of the 41st ACM technical symposium on Computer science education, Milwaukee, Wisconsin, USA.

Tyler, J. (2011). *App Inventor for Android: Build Your Own Apps - No Experience Required!* : Wiley Publishing.

Uludag, S., Karakus, M., & Turner, S. W. (2011). *Implementing IT0/CS0 with scratch, app inventor forandroid, and lego mindstorms*. Paper presented at the Proceedings of the 2011 conference on Information technology education, West Point, New York, USA.

Wolber, D., Abelson, H., Spertus, E., & Looney, L. (2011). *App Inventor: Create Your Own Android Apps*: O'Reilly Media.

Appendix: Resources for Instructors

1. App Inventor: http://appinventor.mit.edu
2. App Inventor 2 (Alpha): http://ai2.appinventor.mit.edu
3. App Inventor Community Gallery: http://gallery.appinventor.mit.edu
4. App Inventor: Create Your Own Android Apps (book): http://www.appinventor.org/projects
5. App Inventor Java Bridge: https://code.google.com/p/apptomarket
6. App Inventor TinyWebDB (default service): http://appinvtinywebdb.appspot.com
7. Balsamiq Mockups: http://balsamiq.com/products/mockups
8. Google App Engine: https://developers.google.com/appengine
9. Google Fusion Tables API: https://developers.google.com/fusiontables
10. Professor David Wolber's Course-in-a-Box: http://www.appinventor.org/course-in-a-box
11. ProgrammableWeb APIs: http://www.programmableweb.com
12. Yahoo! Query Language (YQL): http://developer.yahoo.com/yql