Designing an Introductory CIS Course to Attract and Retain Female (and Male) Students

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Abstract

In order to stem the decline of female majors and encourage the persistence of all students in the Computer Information Systems (CIS) Department at Cal Poly Pomona (CPP), the department faculty is instituting a new course to introduce incoming freshmen and transfer students into the major. This course will incorporate the career exploration that students previously conducted in a junior level class, as well as introduce students to best practices in the computing field. Students will start to build their professional/mentor networks in this class through interaction with alumni, student clubs, presentations by professional organizations, and a hands-on networking workshop. A university librarian, the career center, and a blind woman who will demonstrate the importance of accessibility will conduct other in-class workshops. Students will use social media, critique one another's work, and work in teams and small groups. The goal of the course is to show the value of studying computer information systems and the variety in potential CIS careers. The class design is based on research about attracting students to CIS (particularly members of under-represented groups such as females and minorities), retaining females in the profession, and the positive effects of pair programming.

Keywords: gender, postsecondary education, introductory course, social media, networking, alumni, information technology careers, pair programming, LinkedIn, social networking

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1. INTRODUCTION

The Computer Information Systems (CIS) Department at Cal Poly Pomona (CPP) is part of the College of Business. CPP is one of 23 campuses in the California State University System, the largest public university system in the United States.

Since 1995, CIS majors take JAVA programming as their first course in the major. CIS majors must pass this introductory course with a grade of "C" or better, and can only repeat the course one time to earn that grade. The attrition rate from this course has been high (40-50%), partly because when it was introduced, it was used to weed out students in a major that was seriously overloaded. Since the dotcom bust, however, the number of CIS majors has dropped dramatically, and is now stabilized at around 500 students. There is speculation in the Computer Science field, that the switch to JAVA as the introductory programming course has reduced their numbers of majors as much as did the dotcom bust (Manaris, 2007)

Table 1. CIS Majors by Ethnicity and Gender, Fall 2010 (CPP, 2010)

Ethnicity	Male	Female	Total	% Total
Asian Only	178	13	191	40.6%
Hispanic Latino	94	11	105	22.3%
White Only	71	7	78	16.6%
Unknown	37	4	41	8.7%
Non-Resident Alien	18	7	25	5.3%
Black/African American Only	15	4	19	4.0%
Two or More Races	9	0	9	1.9%
American Indian/Alaskan Native Only	2	0	2	0.0%
Total	424	46	470	100.0%

The numbers of women with careers in Information Technology (IT) also has been dropping steadily for the past 20 years. In 1991, 36% of the IT workforce was female; by 2008, only 25% were female (Ashcraft & Blithe, 2009). In the CIS major in Fall 2009, 16% of the 70 first-time majors were female: 51 new upper division transfers (8 of them female) and 19 first-time freshmen (3 of them female) entered the CIS major. While the numbers of CIS majors is relatively stable, the attrition rate for females seems to be higher. In Fall 2010, only 10 percent of the majors were female (Table 1). This trend is not unique to CPP. Table 1 shows the breakdown of CIS majors by self-reported ethnicity and gender in Fall 2010, retrieved from an internal CPP website.

Faculty members teaching the beginning JAVA course suspect that some females are discouraged and frustrated, because they develop the impression that once they finish college, they will end up as JAVA programmers. Females who take the JAVA course often have no programming experience, while many of the men do. Moving career exploration from a junior-level careers course to this introductory course should help persistence since especially females seem to be leaving the major before they learn about the wide range of careers they may choose, some of which provide the worklife balance or the challenges that they want. The intent of career exploration early in their academic studies is to show females and males both the wide variety of careers they might pursue. It also should give female students, and other less-confident male students, more confidence in their own skills. Research on pair programming indicates that less-skilled students engaged in pair programming courses are less likely to drop the class, and more likely to take another programming class (Braught, Wahls, & Eby, 2011; McDowell, Werner, Bullock & Fernald, 2006).

To combat this downward trend in female participation and to retain and help all students be more successful at choosing a career, the CIS faculty designed a new introductory course. In this new course, students will learn about the CIS field and its career opportunities, and participate in technical projects that are less frustrating than JAVA, and that teach the entire development lifecycle on a simple level. The course design emphasizes interactive activities, speakers, and pair programming. While this course will be female-friendly and benefit from lessons we have learned during our research on women in IT (Guthrie, Soe & Yakura, 2010; 2011; Yakura, Soe & Guthrie, 2012), it also should help males make better career decisions, and give them skills to begin working on their career success early in the CIS major.

This paper presents the plan for the course, which will be offered for the first time during Fall Quarter, 2011. The course design is based on suggestions from the research literature on factors encouraging the retention of female students (Cohoon & Aspray, 2006), the positive effects of pair programming in introductory courses (Braught et al., 2011; Salleh, Mendes, Grundy, 2011; McDowell et al., 2006), as well as our own research findings on the importance of networks of mentors in the successful careers of women in IT (Guthrie, et al., 2010).

We have designed a benchmarking survey that we will give to students the first and last weeks of class. The methodology section discusses its contents and purpose in more detail.

Background

What attracts and retains students, especially females, to a major such as CIS? In their review of the research on female participation in computing education at the postsecondary level, Cohoon and Aspray (2006) drew some assumptions.

- Gender stereotypes deter females.
- Female students have less self-confidence about computing, and low grades discourage them.
- Lack of knowledge about possible careers, and structural barriers to entry deter females from entering the field.
- Females are attracted to classes that have more relevance to the "real" world.
- Female role models, faculty instructional support, peer mentoring, and female peer support improve retention.
- Hands-on, student-centered instructional methods engage female students.

Pair programming originated in industry as part of extreme programming (XP), as a way to produce programs more efficiently and with fewer errors, since one of the pair is always available to do research and to check the work of the other. The two regularly switch roles. Instructors in Computer and Information Science have been experimenting with pair programming in order to facilitate student learning and interest (Braught et al., 2011). Students involved in pair programming projects work together to produce a single product. The students alternate between two roles: one types code (the "driver" role) and the other does research and reviews the code for errors (the

"navigator" role). A meta-analysis of 74 research papers on pair programming versus individual programming in classrooms (Salleh, Mendes, Grundy, 2011) yielded several findings that are important to our course design:

- Pair programming was more satisfying for students, especially when they were paired with a partner who had similar actual or self-perceived computing skills
- Pairs usually produced a final product quicker, although the combined hours the two students spent on the project was greater than the time spent by individual students.
- The quality of the pairs' projects was usually higher than that of individual students, although individual final exam scores did not differ from students who worked alone.

Other factors, such as pairing with a student of the same gender or ethnicity, similar personality, or learning style did not matter. The results for students with a similar work ethic were mixed, and similar time management skills did not seem to matter. Because our female students in the first JAVA class have indicated that they are discouraged about working in our field because they want to "have a life," and because the current millennial generation--both male and female--shares these values (Eisner, 2005), we decided to try pair programming to see if higher levels of satisfaction and success encouraged persistence in the major for all students.

In other research comparing student success in introductory computer science classes that used pair and non-pair programming, students in paired programming classes who were less well prepared before they took the class were more likely to be successful (Braught et al., 2011) and were more likely to complete the course (McDowell, et al., 2006).

Our recent research on the successful careers of women in the IT professions (Guthrie, et al., 2010; Yakura et al., 2012) indicates that the careers of the 38 women we interviewed were enhanced by both their technical and their social or "soft" skills. Their technical skills are expressed in their ability to solve problems for their clients, which relies on their formal education and their ongoing professional training. The social skills included a political understanding of the workplace, their ability to

work on teams, their networking practices, and, if they were lucky, a boss or sponsor to support, mentor, and promote them.

However, only a few of the women in this study were fortunate enough to have a single, strong mentor (usually male and often their first boss). Most of the women had what amounted to a *network of mentors* (Guthrie, et al., 2010). These relationships were less structured in nature, with different mentors providing different types of support in different situations and at different times in their careers. Mentors were particularly important when the women were starting careers or were in transition from one position to another. The concept of building a network of mentors, rather than matching a single student to a single alumni mentor, was one we decided to attempt in this new course.

Based on the recommendations of other academics and on our own research results, we designed a course plan that should provide all students with more information about the field they are entering, help them to begin to build a professional mentor network with alumni and other professionals, with other CIS students, and with each other, and provide the types of activities that should be interesting and inform them about best practices in our field.

2. THE COURSE PLAN

The goals of the new introductory course to CIS are to help students be successful in their academic courses, to learn some of the best practices of the technological work we do in our field, and to jump-start their professional careers while they are in college. In order to make the CIS major appealing, and to reflect the motto of CPP—"Learn by doing"—and the project-based CIS curriculum, the class is designed to be highly interactive, and informative. In order to appeal to the millennial generation (Eisner, 2005), it also utilizes social networking technologies and team activities, including pair programming.

Table 2 (Appendix) shows the proposed schedule for the course, the topics for each week, and the activities and projects in which students will engage.

Academic Success Best Practices

The CIS student population is very diverse (see Table 1), and many of the students are the first in their families to attend college, so they not only need socialization into the IT field, but socialization into academia. Therefore, this introductory class includes activities and assignments to introduce them to concepts and to university and professional services that may help them succeed throughout their academic careers.

Student support resources available on campus to help with academic work include the University Library, the Writing Center, Learning Resource Center tutoring, CIS Department peer tutoring, and Disabled Student Resource Center support for disabled students.

The Librarian who specializes in CIS is providing a workshop on library research, including how to find reliable resources when doing research, what constitutes plagiarism, copyright law, etc. The Library offers workshops such as this one that it adapts for students in different majors, and makes available to classes throughout the university. Understanding these issues should help students avoid problems in later courses that can occur from ignorance.

The student assignment for this part of the course is a research paper on an emerging technology in the field. To help students develop critical thinking skills, each student will use the WordPress blog network installed on a department server to post paper drafts, critique other students' paper drafts, and post their final papers. This project should help them with critical thinking and writing projects in later course.

Introduction to Best IT Work Practices

One of the goals of the course is to socialize students into some of the best practices in the field. Student pairs will develop a small website by following the steps in a prototyping version of the systems development lifecycle. The students will design a website to fulfill the requirements of a small organization that performs community service. Pairs will use the pair programming process to design the website. Again this design work will be published on the WordPress blog. After an instructor critique of the design, the pair will implement and post their results on both of their CPP websites. Individual students will also develop an individual course home page and webmaster page and link it to this website.

Students will use a WSYWIG HTML editor (Dreamweaver) and, as part of the "best practices" goal, learn to develop to W3C HTML5, CSS3, and accessibility standards (using ARIA roles). They will learn how to test their work using browser-based tools, to debug their mistakes, and to correct them. All of these critical thinking skills and best practices are applicable in later classes they will take in the CIS major, and critical throughout their careers in IT.

As they work on this iterative web development project throughout the quarter, they will learn basic design skills, as well as principles of web usability and web accessibility. A blind woman, who works as a technology consultant to companies with visually impaired workers, has agreed to discuss accessibility with the classes, and demonstrate how she uses computers and the Internet. Students may ask her to review their own web sites. Her past class demonstrations to more advanced CIS classes have helped students understand not only about disabled users, but about users in general. Usually a website that is accessible to a blind person is also one that has a high degree of usability for the non-blind user.

The course will give students hands-on experience in the widely varied types of IT work and an opportunity to see how they fit together. Students need to document their design and development plans, best practices for IT development projects. They will develop critical thinking skills needed throughout their studies and careers as they test and critique the work of their peers using principles they learn in class. Students will need to practice communication and writing skills. By performing a mini-development project using many aspects of the software development life cycle, the course work that follows will be understood in the larger context of IT in organizations.

Class Technologies

This generation of students has grown up with technology and is very comfortable using it for personal reasons. One of the goals of the course is to introduce students to the usefulness of current and future information technologies in their professional careers.

The technologies for the class include the Blackboard course management system; on-line tutorials; Dreamweaver, a WYSIWYG HTML editor for building a website to W3C standards; testing tools available as browser extensions; a graphics program, a WordPress blog network; and the professional social networking site, LinkedIn.

Students in the class will build a small website on the CPP web servers. They will use Blackboard for on-line quiz taking covering concepts in the course, as well as for posting certain assignments, and receiving grades and feedback. They also will post assignments on the WordPress blog network, which allows them to provide comments on other students' assignments. A student team as part of their senior project course built the WordPress blog network. They will use LinkedIn to connect to alumni and start building their professional networks.

Students are free to work on group writing projects using file-sharing sites such as Google docs, Microsoft Office Web Apps, or Dropbox technologies. However, they need to post their assignments, including their critiques, on the WordPress Blog site in order to get credit for their work, since the instructor needs ready access to it.

The textbook (see Table 2) is a trade book that covers the systems development lifecycle. It also provides information about free applications that students can download and use to build and test their websites. This book is currently available to students through the CPP library subscription to *Safari Books-Online*. Since tuition fees in the CSU have risen sharply, the availability of on-line textbooks gives all students access to textbooks they cannot afford to buy.

Starting a Career early

One advantage that CIS students have is the strong CIS Department internship program that places them in industry-relevant internships while they are in the program. Our program has had a careers course that students have taken near graduation, in which they do career exploration. That career exploration has now been moved forward to this introductory-level course, so that students do not have to wait until the end of their classes to start planning what they will do after college. This early planning should also allow them to take courses that prepare them for their planned careers, which should speed their progress toward graduation.

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Career exploration in this course will begin early and continue throughout the term. Since the value of professional networking is so important in our research study, the students will begin building their professional networks early in the class. Alumni have agreed to visit the class and discuss different career options with them, and introduce them to the professional organizations with which they can affiliate themselves as student members.

CIS and College of Business student clubs and local professional organizations will make presentations in class. One assignment will be to visit a student club and report on it.

The Career Center will provide a workshop on resume writing and on their services, so that students can take advantage of them when they are looking for internships.

Learning the Value of Networking

Networking runs throughout this class, because it is such an important factor in the success of the women we interviewed in our study. Networking activities include:

- A retired CIS lecturer, who continues to mentor CIS students and who is a master of networking, will talk to classes about the importance of building a professional network early in the quarter.
- About 50 alumni within Southern California, as well as in such distant places as Singapore and Beijing, have agreed to support the students in the class through networking, interviews (both face-to-face and virtual), and speaking in class.
- All of the students will join a professional social networking site (LinkedIn), and then begin connecting to CIS alumni who are contacts.
- An interactive networking workshop will show student how to network face-to-face in a "learn by doing" fashion.

Students will use LinkedIn to connect with alumni who are working in a field that interests them. Alumni have agreed to an interview either face-to-face, or via communication media, such as email, Skype, or FaceTime. Student reports on these interviews will be posted on the WordPress blog network that the class uses. Students will also comment on these peer reports.

4. COURSE ASSESSMENT

In order to assess whether the contents and activities of this class plan help students in understanding the value of networking in building their careers, the research team plans to give pre- and post-tests to the students so that the course can be revised to improve its value. The research team also wants to validate the practical findings of its earlier study to determine whether the continuation of female students in the major will improve if they discover the rich set off career possibilities available to CIS graduates.

The benchmarking pre-survey covers several areas:

- **Technology Experiences:** Questions will help the instructor form pair programming groups that have similar levels of expertise, since research shows that is the most effective for students. Students taking the course will include first-time freshmen, and transfer students, who may have more experience.
- **Demographic:** This information gives an overview of who is taking the course, for analyzing class success.
- **Technology use**: Questions help the instructor understand how students are using technology, and will help focus instruction at a level that suits the class makeup.
- **Information usage and knowledge**: This section provides a snapshot of how students view information sources, and understand issues such as copyright, and research using the Internet.
- **Careers:** This section takes a snapshot of the career knowledge and aspirations of each student.
- **Pair Programming:** Questions take a snapshot of experiences with the method.
- **Professional Networks**: Questions take a snapshot of students' understanding of the value of a professional network, as well as the nature of their professional networks.

The post-survey will be given the last week of class and will be used to ascertain how much students have learned and developed their understanding of concepts in the class. A comparison of the pre- and post-test answers will help the instructors revise the course content and practices. They should provide some

evidence of whether the assumptions underlying the course design are valid.

5. CONCLUSIONS

This paper describes a work-in-progress, a new introductory class that is designed to introduce students to our field of study and the possible careers they can build when the graduate. It also describes the assumptions we used in course design which are drawn from research, including our own.

It is our attempt to improve enrollments and persistence to graduation. Although we used the research on women in IT (by ourselves and others) to design the course, we believe that the conclusions will benefit all students, both male and female. It is too early to draw conclusions about whether it will work or not with this new millennial generation of students.

Our expectations are high. We are encouraged by the comments we received when we solicited the help of alumni for the students. Several of them commented on how much it would have helped to have a course like this early in their academic careers. Alumni are very eager to help these students as they move forward in their academic careers.

6. REFERENCES

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Table 2. CIS 231 CLASS OUTLINE

Textbook: Mark Bell, 2010, Build a Website for Free, Second Edition, Que

Week #: Due?	TOPICS	ACTIVITIES
1, 9/26-9/28 Read: Ch. 1, 5, 6 **DUE 9/28 12 noon** **XTRA credit 1:** on-line survey or alternative short paper	Who are we? What do we do? • Introduction to class content, methods, norms, goals • Introduction of class members • Where do we belong in academic computing fields? • How to start building a professional network	• Course introduction (1.1) • **Ex. 1. Set up your CSU Pomona cis231 website:** file security; VPN; FTP (1.2) • **LinkedIn overview from CIS mentor** • 3 PM, 6 PM (1.2)
2, Oct 3-5 Read: Ch. 3, 4, 7 **DUE 10/3, 12 noon** BB QUIZZES **Exercise 1: Set up your CSU Pomona cis231 website** **DUE 10/5, 12 noon** **Exercise 2: Start your professional network**. Join LinkedIn & connect to instructor & Fred Gallegos; start building network by connecting to 5 alumni	How do we work? • How do we develop a project (SDLC)? • What questions do we have to answer in our analysis? • What do we have to consider when we design a solution? • How do we manage a project? • Introduction to Dreamweaver, a web authoring tool	• Instructor gives Pair assignments (2.1) • In-Class **Begin Project 1.** design work on pair programming website project, Pairs fill in an analysis / design form based on problem (2.1) • **Visits by student clubs:** & **CBA undergrad advisor (& CIS alumna)** (2.2)
3, Oct 10-12 Read: Ch. 10, 11, 13, 14 **DUE 10/10, 12 noon:** **Project 1** Post on Blackboard (3.1) BB QUIZZES **DUE 10/10 AT END OF CLASS** **Exercise 3:** in-class pair debugging exercise (3.1)	How do we develop our product solution? • What about developing to standards? • Developing for a specific audience • Testing with browser tools • Debugging errors	• Dreamweaver & browser testing tools (3.1) • **EXERCISE 3**. Pair testing / debugging exercise IN-CLASS (3.1) • Begin **Project 2**. PAIR WEBSITE design. Post on each student's CPP website (3.1) • Begin **Project 3:** Create simple individual website with 2 linked pages: home page & webmaster page. Connect to Project 2 pages (3.2)
4, Oct 17-19 Read Ch. 12 +online readings **DUE 10/17 12 noon**: BB quizzes **DUE 10/19, 12 NOON:** **Exercise 4,** individual blog report on visit to student club **Projects 2 & 3:** Pair website design	How can we ensure that audience will be able to use our product? • Designing to appeal to intended audience • Trust building with customers • Usability issues	• Class Usability exercise – Krug Trunk Test (4.1) • Pairs work on websites (4.1) • **EXERCISE 5:** Pairs Accessibility testing exercise – evaluate another Pairs' Project 2 & identify any accessibility issues; written

& 2-page individual website with photo posted on CPP website of each student *DUE AT END OF CLASS 10/19* **EXERCISE 5,** Pair's accessibility testing exercise of another pair's website, posted on blog site	• Accessibility issues	feedback (4.2) • Begin **Project 4**, fix issues with Projects 2 & 3, develop content
5, Oct 24-26 Accessibility demonstration (5.1) Midterm (5.2)	Accessibility demonstration & midterm exam • Accessibility demonstration (5.1) • Midterm (5.2)	• **Demonstration of how a blind person** uses technology (5.1) • Some students have Andrea review their websites for accessibility (5.1) • Midterm (5.2)
6, Oct 31-Nov 2 ***DUE 10/31 12 NOON:*** BB QUIZZES **Exercise 6.1:** Preparation of draft resume. Post on blog	What are the careers of the future that you might consider? • What are your interests? • What qualities / values do you have?	• **Career Center Workshop** --in-class or at Career Center (6.1) • Critiques of resumes • **Group Exercise 7.1:** Career exploration by groups of students interested in similar careers. Generate questions to ask alumni speakers (6.2)
7, Nov 7-9 Online readings ***DUE 11/7, 12 NOON*** **Exercise 6.2. Critique of partner's draft resume** **Exercise 7.1:** group reports about careers & proposed questions for alumni speakers, POSTED ON GROUP BLOG	• Social media • Security & forensics • Web development: Web services, cloud computing • Games, animation, digital media • Mobile devices	• **Speaker from the library on how to conduct library / web-based research** 2PM Monday, 6PM Wednesday • **Interactive Networking Virtual Workshop** 6PM Monday, 2 PM Wednesday • Begin **Project 5.1**, research paper draft
8, Nov 14-16 BB quizzes Online readings **Ex. 6.3** revised resume ***DUE 11/14, 12 NOON*** **Project 4:** 2nd iteration of website with revised layout, design improvements, & additional pages (8.1)	What are the professional groups to which we belong? • Professional ethics to which we subscribe? • Power & politics in IT work	• **Alumni speakers (8.1. & 8.2)** • Group interviews of alumni whose careers are of interest to group • **Exercise 7.2** group blog report on alumni answers to questions • Professional Organizations
9, Nov 21-23 ***DUE 11/21, 12 NOON*** **Project 5.1**: draft of research paper on emerging media, posted on pair blog site BB quiz Ch. 8, 15, 19 ***DUE 11/23, 12 NOON*** • **Exercise 8:** critique partner's research paper in a blog • **Exercise 7.2** group blog report	Integrating social media for business use • Facebook, blogs, twitter • Search Engine Optimization • Google Analytics	• How can Facebook be used for business? • **Group exercise 9**: Social media: Prepare a Facebook page, a Twitter site, and WordPress Blog site. Connect them to your individual websites • Blog, tweet, read the same message everywhere

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on alumni answers to questions • **Exercise 7.3.** Answers to career questions from at least one person in your LinkedIn network, posted on individual blog		
10, Nov 28-30 Ch. 16, 17, 18 ***DUE 11/28, 12 NOON*** BB quizzes ***DUE 11/30, 12 NOON*** **XTRA credit 2:** on-line survey **DUE 12/2 12 midnight.** **Project 6:** Entire updated web portfolio, including • Updates to website • **Group exercise 9**: Social media: Prepare a Facebook page, a Twitter site, and WordPress Blog site. Connect them to your individual websites • **Exercise 6.3. Final resume** • **Project 5.2:** Final version of research paper	Final roundup • Training, testing, documentation, implementation tactics • Finalizing digital student portfolios • Open Labs to work on final project	• Consult with instructor and peers for help with final project • Test partner's project for errors and help partner correct the errors
Finals, December 5	• 2 PM class: Monday, 1:40-3:40 • 6 PM class, Monday, 6-8 PM	• Final exam

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