Group Interaction and Its Impact on the Experience Gap in Higher Education IT Classes

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INTRODUCTION

Women often enter college level courses with an experience gap that can prevent them from completing majors in computer science as well as in other IT programs. Project courses that provide opportunities for collaborative learning are often touted as an excellent way to enhance learning and to retain women in IT-related education programs. They are also strongly encouraged by the recent IEEE Computer Society/ACM Computing Curricula Task force (CC2001) as a critical component of curricula that produce computer science professionals rather than narrowly focused programmers. In this chapter, we will discuss findings that indicate that creating project-based, collaborative learning opportunities for students is not enough to engender the type of learning that will enable women to bridge the experience gap but in fact, can widen the gap.

Research on group interaction and collaboration has a long and multi-disciplinary history. A great deal of this literature focuses on collaboration in work and learning environments and should inform the construction and use of project-based collaboration in ways that enhance each participant's learning. Within the context of this literature we will examine a case study that is based on extensive hourì¥Á 5@ ┘ ø↕ ¿ ┼ − àT

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Only parenthetically do the authors remark on the possible need to acquire new knowledge.

> Fincher, p.xii: craft-skills model: "Every discipline has its
> distinctive way of knowing which it identifies with the activities
> it regards as its own...." (Agre, 97)

In this paper, we focus on multi-disciplinary project work. Such projects benefit from the contributions of students from a variety of majors. In working on such projects, computer science majors with their technical expertise may have the unusual experience of teaming with advertising or Spanish majors who bring strengths in design or content development. The advantages of such mixed-skill teams are notable. Team members learn from each other as they share diverse knowledge and abilities. In particular, team members gain both by learning from those who are more capable in certain areas and by helping those who are weaker. By adapting to the various abilities of the team members, they learn how to rely on others.As part of team building, students are also required to assess their own strengths and weaknesses. [Fincher]

One major drawback to mixed-skill teams is the overhead imposed by the negotiation of project roles. It can take time for the group to coalesce as all members learn what skills and interests the others bring to the table. [Fincher] In addition, students often opt to play to their own strengths thus limiting the possibility of learning new skills on their own or from each other.

RESEARCH ON GROUP INTERACTION AND COLLABORATION

Ideal student work groups are heterogeneous and their group tasks require that all students share their knowledge and expertise as well as their questions and uncertainties in ways that lead to peer learning **Error! Reference source not found.**. However, this ideal assumes that students take equal responsibility for the roles of teacher and student; and that tasks focus on learning through dialogue and hands-on activities **Error! Reference source not found.**. Knowledge asymmetry, when one group member is more expert on a topic than another, is to be encouraged and expected in group projects because it creates an opportunity for peer tutoring, which is beneficial for both the more expert and less expert students. Further, in successful learning groups, students alternate between different types of roles and communication: those involving peer tutoring in which the roles of "teacher" and student(s) are clear and well defined; and collaborative sequences where students work together in free discussion to create knowledge and understanding with no clear role differentiation **Error! Reference source not found.**].

Yet simply putting students in project groups does not automatically lead to improved learning through the processes described above, because students often do not know how to collaborate effectively. Instead, they often divide the work, taking on that part which is most consistent with their "comfort zone." Only when group processes are made explicit can group activities can lead to enhanced learning [**Error! Reference source not found. Error! Reference source not found.**. Group work can have other implications for female students. For example, knowledge asymmetry can interfere with peer learning during teacher-student exchanges if students do not take turns being the teacher or the student. Since males tend to have more experience with computer technology when they begin computer science studies, women may tend to become the student more often than men, resulting in decreased self-confidence. Women's lower self-confidence has been shown to precipitate a decision to switch major **Error! Reference source not found.**]. Thus it is important for professors to help students to manage their group experiences.

In the next section, we explore a case study of four project courses illustrating two of the primary pressures student groups face in completing group projects: experience and time allowed for completion of the assignment. These pressures can lead to situations where the experience gap typically found in CS classrooms is maintained or even widened.

A case study

Arapahoe: Students were required to develop a web site highlighting Arapahoe culture. Technology experience varied from none to extensive experience with C++ programming. Student learning outcomes were web site design and digital video production, employing HTML, Flash, Photoshop, and Final Cut Pro, interviewing, and making digital records of their subjects.

Multi-Disciplinary CS Project (MDCS): This class brought real community service organizations together with students to create technological solutions for their needs. Student learning outcomes included the rudiments of UltraDev, Dreamweaver, Access, task-oriented design, and working with clients. However, student expertise with "canned" software and programming ranged from novice to expert in areas such as Flash, Photoshop, HTML, Java, Access, C++ and other languages, and database development.

Capstone A: Students were required to develop an educational web site for a high-profile geo-science institute on campus. Students' level of experience with and expertise in canned software such as Photoshop, Form Z, and Flash ranged from novice to expert, including several students with C++ and Java programming experience. Intended student learning outcomes included advanced Flash animation and experience serving a client as part of a project team.

Capstone B: The project provided students experience in developing and implementing an educational web site. This class did not require that all students have prior experience with programming or high-end software; half of the students had little or no technical skill. Student learning outcomes included learning project management, increasing technical skill (depending on the starting place of each student), and a rudimentary understanding of educational theory.

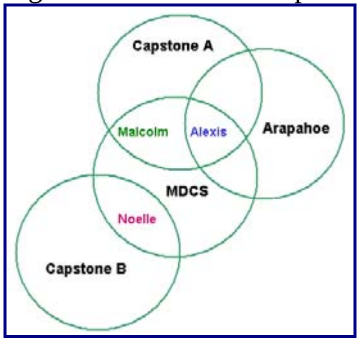
A Tale of Three Students

In our focus group interview with the students of Capstone A, several students revealed a perception that they had not been given the opportunity to gain more experience in computer skills involving the during the class. They were unclear about why this might be, but felt very strongly that it had "happened to them." It was these statements that led us to more deeply examine our field notes from observations to find out what happened.

We had a highly unusual vantage point in that we were able to observe different group functions or roles performed by the same students in more than one setting. That is, during the fall 2001 semester, three (two female, one male) of the 13 students in MDCS were concurrently enrolled in the Capstone A class, one (female) was also enrolled in Capstone B, and one female was enrolled in three of the classes (MDCS, Capstone A, and Arapahoe) (see Figure 1). Seeing the students across these varied classroom contexts made visible the multidimensional character of students' capabilities with respect to software development. That is, both the male and female students had adopted different roles and evidenced different areas of expertise in each class. If an instructor had not seen one of the students take charge of the technical aspects of a project in one class, he or she might not know her as a student with high computer confidence and competence.

In MDCS, Noelle (studying ITP, Spanish, and Education), Alexis (studying ITP, Journalism, and Molecular Biology), and Don (studying CS) formed a team to create an educational web site for middle school children in a bilingual charter school. They attended a workshop including the school principal, conducted interviews with her, and visited the school to understand the teachers' and children's needs. Building the site required design, content, and HTML coding.

Figure 1: Student Overlap Across Classes



The students split up the work along disciplinary (perhaps gendered) lines, with Noelle and Alexis making most design and content decisions and Don doing the HTML coding. It is easy to see why Noelle, as a Spanish major and pre-service teacher, would be especially good for providing content. However, Don's and Alexis' roles were not quite so straightforward and were negotiated through many interactions. For example, at one point, the three were discussing icons and images. As Alexis told Don at length why she saw an image as particularly good, he repeatedly expressed agreement with her, but she didn't acknowledge it. It was as if she could not register that he might possibly know enough about images to agree (rather, he needed instruction or to simply accept her opinions). On another occasion, the team was having a technical problem saving a file as a GIF. Noelle's opinion overrode Don's suggestion for solving the problem on the implied basis that she had a better eye for image quality; his solution, she said, would diminish the image's quality.

Yet Don was clearly conscious of design and thoughtful about content. For example, when deciding on the approach to helping children find the help they need with research, the purpose of the site, it was his idea to use questions ("Do you want to find a book?") rather than headings ("Research") because "kids don't think in those terms." During whole-class discussion about intuitive tasks, Don pointed out that in the Macintosh interface, dragging the floppy disk icon to the trashcan to eject can make people afraid that they're somehow deleting files on the disk. In fact, throughout the project, we documented many of Don's insightful comments about the site's appearance and content. But with his ideas and knowledge repeatedly ignored or brushed aside, Don learned implicitly that design and content were not to be his domain.

Noelle and Alexis seemed to have staked out content and design as their territory. This may appear to be gendered, yet is also by virtue of their unarticulated beliefs about what kinds of people should make what kinds of contributions. During the focus group interview, ITP students discussed the image of a computer science major. Alexis said, "I've taken a C++ programming class and there's really no creativity there." It is not clear whether Noelle shared this belief (certainly several other students objected to this), but Alexis's inability to see computer science as "creative" may have impeded her ability to "hear" Don's design ideas. Her initial beliefs and the implicit messages embedded in many interactions were likely a factor in Don's relegation to HTML coding–at the expense of his apparent desire to participate in design decisions.

Also interesting here is the revelation that although Alexis adopted the role of content and design specialist in the MDCS class, she actually had programming experience and very likely was successful. Alternately, in Capstone A, where many of the male students were fine arts majors with extensive design and programming experience, Alexis worked on content only. In fact, the only arena where we observed her applying technical knowledge was in the Arapaho class, where Alexis so successfully supported her non-technical peers that the she was offered a teaching assistant position. When we asked Alexis why she and Noelle did mainly content and design and Don the coding, she narrowly characterized Don's contribution, explaining that he was a fast programmer, that she and Noelle had made a similar web site before, and they were under time pressure (more on this later). In spite of her own ability to function in any of the three roles, Alexis was unable to see Don, a CS major, as functional in the roles of content and design. In fact, all three of those students could have provided more input or support in all three knowledge domains.

Noelle's participation and role(s) in Capstone B provides further evidence of student role switching. In this class, students developed a web site requiring HTML programming, Flash scripting, and video editing. Unlike MDCS, where students negotiated their goals informally, the professor of Capstone B assigned student roles, though he did not communicate these explicitly nor do we have evidence that he intended the outcomes. Intentional or not, however, communication is instrumental and produces effects. Early in the semester, the professor called on students in class to list their relevant skills. Only two of the six students enrolled, one male and one female, were ITP students; three (females) had very little technical expertise beyond common applications. One male student, Mark, had extensive experience with Flash. Noelle and John had rudimentary experience with Flash, a requirement of the introductory ITP Project class they had taken in a prior semester. Noelle's Spanish came into play again because the school was bilingual and the web site was about a trip to Mexico; however, she was also very proficient with HTML, as were Mark and John. Later, when the professor was discussing the kinds of technology they might need for producing an interactive map for the school, he mentioned needing to use Flash, made direct eye contact with John and said, "because you have experience and interest in that, right?" John, quite a bit less experienced with Flash than Mark, nodded agreement. This set the stage for the two males to extend their experience with Flash. About six weeks later in the semester, the professor described the students' roles, saying, "we have a lot of talent in this class. Mark is accomplished in Flash. John, you also know Flash. Noelle, you have the opportunity to put your Spanish to work online." Of course, by now, John had six weeks more experience with Flash than Noelle as a result of the not-so-subtle assignment by the instructor. Note that the other three females' "talents" were unmentioned and the only technical "talents" were attributed to the males. Though Noelle did far more technical than content work in the project, her "talent" was cast as content-related.

Based on the Flash skills and "interest" of the males, the division of labor became clear: the males scripted Flash, the non-technical females selected and edited content, and Noelle performed all HTML coding, taught some HTML to the other women, and managed the content integration. The professor provided opportunities for the three less technical women to acquire some technical skills during the semester (digitizing video, video editing, scanning, and Photoshop) so they could do their parts. Noelle sometimes stood behind John and Mark to ask questions and watch what they were doing with Flash. Yet the project roles gelled, and in the interest of finishing up the project, the students took on roles based on what they already knew best. Noelle ended up doing the same job left to her partner Don in MDCS: significant HTML coding.

Like Alexis, Malcolm was enrolled in both MDCS and Capstone A; like John and Noelle, Malcolm began the semester with basic knowledge of Flash. In Capstone A, however, three male class members were highly skilled designers (artists, really) and highly technically proficient in Flash. So in spite of Malcolm's desire to become more proficient in Flash, the instructor implicitly assigned Malcolm and the four women (including Alexis) in the class to select and edit the content. He said, "we're in a hurry to get this done, so we're going to have [the three male artists] do the Flash." In MDCS, we overheard Malcolm express frustration with this turn of events, because he wanted to learn Flash under the guidance of the lead ITP instructor rather than on his own. Nevertheless, in MDCS Malcolm and two female ITP students used Flash to script a complicated tutorial for senior citizens on how to search the web. Therefore, unlike Noelle, Don, and Alexis, Malcolm was more successful at expanding his development repertoire through his own motivation and because the MDCS professor did not prescribe roles.

Failure to bridge the experience gap

Design and implementation of collaborative group learning opportunities