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Online Learning Communities Prove Effective in Recruiting Students into Computing Majors at Illinois State University

Anu A. Gokhale

Department of Technology • Illinois State University

Dr. Anu A. Gokhale (Ph.D., Iowa State University) is a Professor and Coordinator of Computer Systems Technology program at Illinois State University. Dr. Gokhale presents and publishes her peer-reviewed research, and pursues multi-year projects funded by agencies like the US Department of Education, US Department of State, and National Science Foundation. Dr. Gokhale recently authored a second edition of her book Introduction to Telecommunications, which also has an international edition in Chinese. She was a Fulbright Scholar in 2001, and was honored with the University Outstanding Researcher Award in 2011. Dr. Gokhale is an active volunteer in IEEE (Institute of Electrical and Electronics Engineers), has served on the Educational Activities Board, and was honored with the IEEE Third Millennium Medal.

Kenton F. Machina

Department of Philosophy • Illinois State University

Dr. Kenton F. Machina (Ph.D., University of California, Los Angeles), now Emeritus Professor of Philosophy, was formerly the Chair of the Department of Philosophy at Illinois State University and was appointed to a three-year term in the Tom and Janet Andes Chair of General Education. He currently holds a position as Emeriti Faculty in the Department of Technology at Illinois State.

Research suggests that the perceptions of students, educators, and other stakeholders play a large role in discouraging women and minorities from pursuing computing-related majors and participating in technical occupations. This NSF-funded project utilizes online learning communities to make computing disciplines more attractive to prospective students — particularly female and minority students — by providing them with a better sense of the range of opportunities in computing and the role of computing in addressing real issues about which people care. Additionally, students are challenged to examine stereotypical and constraining definitions of "femininity" and "ethnicity" and overcome these barriers. Findings show that these methods do not alienate the majority white males and are effective in recruiting students, especially women and minority students, into computing-related majors.

Keywords: online learning communities, recruiting, computing-related majors

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Advances in computing are among the most powerful forces bearing on the economy (Castells, 2011). Computing applications continue to impact medicine, finance, manufacturing, and numerous other sectors of society. Knowledge of advanced computing has the potential to prepare students to apply and innovate upon 21st-century technologies (Oh, 2003). Computing-related fields have tremendous job opportunities and represent some of the highest-earning majors. Although Blacks comprise 12 percent of the total population and 11 percent of the workforce in the United States, they account for only three percent of the employed computer scientists and engineers (Campbell, Denes, & Morrison, 2000). The low proportion of participation is also true for women. Despite the fact that women comprise 46 percent of the nation's workforce, they only represent about 15 percent of jobs in science, technology, engineering, and math (STEM) as well as computing-related fields (Wasburn, 2006). Current research suggests that the perceptions of students, educators, and other stakeholders play a large role in discouraging women and minorities from pursuing computing-related majors and participating in technical occupations. When coupled with strong implicit stereotypes about competencies, students who maintain a strong gender and/or racial identification are particularly susceptible to stigmatization. The stereotype threat theory posits that the mere threat of being stereotyped is sufficient to discourage this population from careers dominated by White males. Friedman (2005) indicates that society is becoming more and more knowledge-based, technological, and international. Further, Lubinski and Benbow (2006) assert that the physical and social systems within which people operate are becoming more complex and dynamic. Countries that maintain a competitive edge and prosper will be the countries that are the most effective in developing their human capital and in nurturing individuals with the capabilities of developing new ideas and innovations. According to Tyler-Wood, Knezek, and Christensen (2010), 80% of US manufacturers experienced a shortage of STEM workers in 2007. Our current economic situation accentuates the need to identify workers that have the potential to bolster our industries and provide job opportunities for our citizens. In direct response to the concern about shortages of information technology (IT) workers in the United States, the authors of this study were funded by the US National Science Foundation (NSF) to pursue a project to recruit more students, especially females, into computing-related majors at their home institution.

According to Roberts, Kassianidou and Irani (2002), although some of the barriers faced by women and minorities are founded in cultural expectations established well before the college level, universities can take effective steps to increase their recruitment and retention of these populations. College students often change majors more than once, especially in their first two years, as they flirt with possible occupational futures, discard them, and pursue others (Arnett, 2001). It is not too late to reach out to college students, especially those who have developed the required mathematical skills, to consider a computing-related major or minor. However, research suggests that traditional methods of recruiting women and minorities into computing programs are not working well enough (Hurtado, 2007).

Qualitative research involving 18 large computing departments across the US (Cohoon, 2002) showed that undergraduate women who decide to major in computer science often do so for the following reasons: 1) They believe that computing fits their personal strengths or abilities; 2) They have friends and family who support their decisions to major in this field; 3) They believe computing offers an opportunity to be creative; 4) They anticipate careers that pay well and offer a variety of ways to apply their skills.

On the other hand, when we focus our attention on women and minority students who do *not* choose a computing major, we find that there is a widespread misconception about the field. According to Frieze (2005), the dominant image suggests that the field is populated by "geeky guys," and a computing job is seen to consist of little more than coding. The image of computing as a broad and exciting field with the potential for diverse participants is, for the most part, missing from the students' perceptions.

These claims are consistent with the authors' earlier work. It was found that in order for female college freshmen to maintain a positive attitude toward science and technology, and toward female participation in that field, it may be necessary to intervene in their educational experiences. The aim of this intervention would be to humanize those fields in the eyes of the students and inform them about the real activities of actual professionals, including female professionals, in those fields (Machina & Gokhale, 2010).

Literature Review

Learning communities consisting of education professionals are popular in current school improvement circles (DuFour, DuFour, Eaker, & Many, 2010); however, this concept is not new. It began in the realm of business with the understanding that organizations can learn. Agents for change in education borrowed the concept in an attempt to improve student learning. Regardless of whether the aim is to enhance learning or increase recruitment and retention, in educational contexts the term “learning communities” traditionally has been applied to programs that involve first- and second-year undergraduates. A variety of approaches are used to build community among students and between students as well as their instructors within and across disciplines (Senge & Scharmer, 2006).

Considerable attention has been given recently to the “Net Generation,” also called the “Y Generation.” This group of individuals, born between 1980 and 1994 (McCrindle, 2006), has been characterized by their familiarity with and reliance on information and communication technologies. They have “spent their entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age” (Prensky, 2001, p. 1). Several authors have argued that the digital culture in which the Net Generation has grown up has influenced their preferences in a number of key areas related to education. For example, these students are said to prefer receiving information quickly; to be adept at processing information rapidly; to prefer multi-tasking and non-linear access to information; have a low tolerance for lectures; to prefer active rather than passive learning; and finally, to rely heavily on communications technologies to access information in addition to carrying out social and professional interactions (Clark, 2012).

Anderson and Lin (2009) conducted a study using virtual collaborative communities in upper-division computer science courses. Their results show that blogs are an effective tool for creating an inclusive learning environment for diverse students. Learning specialists Fernette and Brock Eide, cited by Richardson (2010), contend that blogging has a great deal of potential positive impact on students. For example, blogs can:

- Promote critical, analytical, and analogical thinking;
- Be a powerful promoter of creative, intuitive, and associational thinking;
- Be a powerful medium for increasing access and exposure to quality information;
- Combine the best of solitary reflection and social interaction.

The Net Generation has embraced the concept of publishing on the web, and that bodes well for the study’s use of emerging technologies to communicate with Net Generation students. Kennedy et al. (2006) purport that universities are ill-advised to recruit and retain a new generation of learners whose sophisticated use of emerging technologies is incompatible with more traditional recruiting practices.

Goals and Objectives

The project creates a student learning community (SLC) with the goal of fostering an academic, social, and cultural environment to encourage students to enroll in a computing-related major or minor, or explore the field of study by taking one university-level course in computing. Additionally, the project seeks to change students' attitudes, especially those of women and minority students, toward computing, as well as to build connections among students. Enhancing student engagement in this way would be important for helping students to retain their academic eligibility for a computing major.

Methodology

The purpose of this study is to increase student enrollment in computing-related majors or minors by recruiting from the pool students who are admitted to the institution and are taking a Finite Mathematics course required by these majors.

Population and Sample

The population for this study consists of students enrolled in a freshman-level Finite Mathematics (Math 120) course. Math 120 is required in five computing-related majors at Illinois State University, where the study is conducted. Four to five sections of this course are offered each semester. The sample for the study is drawn from five semesters of one large section of about 180 students per semester. The majority are freshman, who are given the opportunity to participate in the study by signing the Informed Consent form at the beginning of the semester. A control group is created each semester by university administration and consists of students enrolled in the remaining sections of this course. The control group is matched with the experimental group with regards to number of students, gender, and class standing.

Intervention

Online learning communities are facilitated through the use of blogs. A blog (short for web log) is a web page that serves as a publicly accessible personal journal for an individual or a group. Typically updated daily, blogs often reflect the personality of the author(s). A blog is different from a website because it is not built on static chunks of content. Blogs engage readers with ideas, questions, and links, and ask readers to think and to respond. In this way, they demand interaction. The blogs in this project promote a student community knit by common interests, and provide a sense of support for students who are contemplating a computing major, especially women and minority students.

Every semester the project hires four junior/senior computing majors with demonstrated web authoring skills to author blogs using WordPress, a free web-based blogging service. The project directors make special efforts to recruit female and minority students for this task. According to Richardson (2006), newer online features, such as blogs and videos, are much more popular with the Net Generation when younger staff members and current students create the content for these high-tech tools. Moreover, the upperclassmen student leaders serve as role models and mentors for freshman students who have the potential to succeed in a computing major. Blogs are posted twice a week and study participants are given an incentive to read the blogs: each blog has an associated quiz on Blackboard so that students can earn extra credit, which could be up to two percent of the total grade points of the course.

Computing disciplines are made more attractive to prospective students — particularly female and minority students — when those students are provided with a better sense of the range of opportunities in computing and the role of computing in addressing real issues about which people are concerned. The blogs counter the myth that computer science is merely programming. Student bloggers are asked to be creative — write diary-like entries, and place videos, photos, podcasts and more — but, their work must all be related to computing, and especially designed to motivate women and minorities enrolled in the math course to explore a computing major. Examples of blog posts include: quizzes and games based on mathematics concepts essential to computing disciplines; guided discussions; videos on exciting careers related to computing applications; interesting stories about famous and not-so-famous women and minority computer scientists; and lastly, contributions of computing professionals in solving societal problems. Furthermore, the blogs provide a challenging, substantive context for the mathematics requirement for computing majors. The blogs are closely monitored by the project directors for accuracy and appropriateness of content.

Results

The data in Table 1 below includes participants over the past five semesters. In order to be included in the experimental group of students, a student was required to give consent and pass the Math 120 course. In order to be included in the control group, a student was required to have been randomly selected from among those students who passed Math 120 from any section of the course with which we did not work. The control group was formed each semester to match the experimental group from that semester in terms of gender and class standing. Each cohort of the study population is identical in size and key demographics (i.e., gender and class standing) to each cohort of the control group, thus making comparisons between the study population and control group meaningful.

Table 1
Description of Enrollment in Computing Programs – Before and After Intervention

Category	**Experimental** Male (n=462) Female (n=425)	**Control** Male (n=462) Female (n=425)
Initial computing major/minor retained after Math 120 Male Female	 30/32 (93.7%) 9/9 (100%)	 38/42 (90.5%) 7/9 (77.8%)
Initial computing major/minor dropped after Math 120 Male Female	 2/32 (6.3%) 0/9 (0.0%)	 4/42 (9.5%) 2/9 (22.2%)
Students who chose a computing major/minor after Math 120 Male Female	 4 4	 5 1
Students without an initial computing major/minor who enrolled in at least one computing course after Math 120 Male Female	 9 5	 6 3
Net count of all positive changes noted in the rows above Male Female	 11 9	 7 2

Ultimately, both the experimental group and the control group each consisted of 887 students, 88% of which were freshmen at the start of Math 120. Sophomores constituted 9% of each group. Overall, 48% of each group taken was female, but this percentage varied considerably by semester. One can generally read “major/minor” as “major,” because less than 10% of the participants were minors in total among the experimental and control groups.

The project yielded 100% retention of computing major/minor females (9 out of 9) in the study population as compared to 7 out of 9 females in the control group, thereby yielding a 22% drop rate for the control group. Moreover, when comparing net overall positive changes — enrollment in key computing courses and computing majors/minors count — the results for the study population are strikingly different from the control group results. There was a net positive change of 20 students (includes males and females) in the experimental population as compared to 9 students in the control group. In effect, the study population yielded a 122% increase in computing course enrollment, as well as major count, as compared to the control group.

The students in these groups will continue to be tracked by the administration in coming semesters. Many of the previously reported differences between the study population and the control group did not emerge until at least a semester after the intervention (student participation in Math 120). Thus, it is important to continue the tracking process over a few more semesters.

Discussion and Conclusions

The student learning communities are designed to increase student awareness of the diversity of careers for computing majors, to tap into antecedent student interest in issues that are relevant to computing, and to humanize the computing field, particularly in the eyes of female and minority students. The apprehension surrounding computing experienced by women and minority students stems from doubts about self-efficacy, a lack of understanding of work life of the professionals in this field, and perceived academic and social obstacles to succeeding in these majors. The online learning communities are effective in demonstrating that the field is not dominated by “geeky”, White males, and that women and minorities can, and do, contribute.

The project strategies have proven to be highly effective in motivating students to consider computing-related majors. In terms of enrollment in computing-related courses or majors, the study population did strikingly better than the control group. The experimental group yielded a 100 percent increase in enrollment, as well as major count, as compared to the control group. It is expected that constraining definitions of “femininity” and “ethnicity” will be challenged; females and males, as well as Whites and non-Whites, will continue to forge more expansive definitions of these terms. The model exemplified in this study has the potential for replication at comparable institutions.

The project directors have designed a scale to measure students' attitudes toward computing (Gokhale, Machina, & Brauchle, 2013). This scale has been administered to students in both experimental and control groups. The authors are currently in the process of analyzing data to examine if there are any significant differences between the experimental and control groups.

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