Undergraduate Minorities in IT-Related Fields: Findings from a Case Study in a Minority-Serving Institution

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Abstract

This paper reports some conclusions from the fieldwork on the experiences of undergraduate minority students majoring in information technology (IT) related fields—computer science (CS) and computer engineering (CE)—in a minority serving institution. The main goal of the study was to understand minority students' attachment to and detachment from the IT-related fields.

Introduction

The number of under-represented minorities (Afro-Americans, Hispanics, and Native Americans), who make up 24% of the U.S. population, either training or working in IT occupations is rather low. For instance, the 1999-2000 Taulbee Survey notes that Afro-Americans earned 324 (4%) of CS and 72 (4%) of CE bachelor degrees. Similarly, Hispanics earned 292 (3%) of CS and 74 (4%) of CE bachelor degrees; the figures for Native Americans were 31 (0%) and 4 (0%), respectively. This is in contrast with Asians who earned 1988 (23%) of CS and 319 (17%) of CE bachelor degrees; and whites who earned 4,744 (55%) of CS and 1,106 (59%) of CE bachelor degrees. Since IT plays an increasingly pervasive role in workforce productivity, economic growth, demand for labor, and skill upgrades in the workplace, this underrepresentation of minorities is critical for the American society increasingly dependent on technology.

There is little scholarly work related to the racial/ethnic gap in IT. Most work has been on broader issues of the under-representation of women in science and engineering, since it is assumed that many of the reasons that discourage women from science and engineering careers may also apply to minorities. Recently, the National Action Council for Minorities in Engineering has covered the participation of minorities in science, mathematics, and engineering. Margolis and Fisher have studied the gender gap in CS at the undergraduate level at Carnegie Mellon University. Tapia has helped to increase the number of minority graduate students at Rice University in applied mathematics from 5% in 1985 to 38% in 1999. The Computing Research Association has come up with practical advice to recruit and retain underrepresented minority graduate students in CS. However, there is still little work directly related to the minority undergraduate students in IT-related disciplines, especially in minority serving
institutions of higher learning. Disparities by social class and race/ethnicity are strongly related to pipeline progress in science and engineering related disciplines\textsuperscript{7,10}.

This paper reports the findings from a case study conducted at the University of New Mexico (UNM), a Doctoral Intensive and a Minority/Hispanic-Serving Institution. UNM grants undergraduate degrees in both key IT-related fields—CS and CE. Due to its proximity with national laboratories (e.g. Sandia & Los Alamos laboratories), private industry (e.g. Intel), and the state government, IT education at UNM offers excellent job and career opportunities for New Mexico residents, especially minorities. However, only 35% of undergraduate students enrolled in CS and 32% of those enrolled in CE are under-represented minorities; whereas 45% of the total UNM undergraduate student population is minorities. Most of the undergraduate CS and CE students are from New Mexico, which ranks on the bottom in the nation for personal income per capita, median household income, and percentage of persons living below poverty level.

Methodology

With the goal of understanding what makes minority students attach to or detach from IT-related fields, the technique of ethnographic interviews was utilized. This method studies the topic from the subjects' point of view rather than from the experts'. In-depth interviews were conducted with 40 subjects at UNM. This sample size includes 34 undergraduate students majoring in CS and CE, and another 6 students who have switched from IT to a different program of study, namely information systems offered by the School of Management. All students came from different ethnic backgrounds: white (7 female and 4 male), Hispanic (7 female and 4 male), Native American (4 female and 3 male), Asian (4 female and 4 male), and Afro-Americans (3 male). This cross-gender and cross-cultural sample size was designed to provide a better understanding of the issues related to the lack of participation by minorities in CS and CE education and careers.

The interviews were based on both structured and unstructured formats. They were structured in the sense that certain topics were covered; they were unstructured in the sense that they more closely resembled a private conversation with the subjects. Such a combination allowed subjects to express themselves in depth, while the interviewer maintained a certain control over the topics, and was able to probe further on interesting leads. These interviews lasted anywhere from 45 minutes to almost two hours. Each interview was audio taped. After the interviews were transcribed verbatim, the Nudist software program was used for qualitative analysis. The data were coded for all issues that have any bearing on students’ attachment to IT, preference for any other major, and detachment from IT. They were also sorted by ethnicity, gender, and IT-fields. Yet, the subjects' original story was preserved as much as possible.

Findings

1. Digital Divide

Even though computers and other digital technologies have been widely diffused both at home and in the K-12 educational system, under-represented minority students differed in their early access to computer technology and in their use of computers before attending UNM. Most of the
under-represented minority students interviewed did not have a computer at home or in their elementary and middle schools. Their high schools usually had computers outside the classroom (e.g. library or instructional room), and few were ever taught in computing classes. It was not their race that contributed most to their lack of access to computer; instead, it was their economic status and the educational background of their parents. Many under-represented minority students characterized their family’s economic status as lower middle class and occupational status as working class. Yet, these students identified themselves and their family members as having a positive attitude about owning computers and being connected to the computer revolution. Those who had an early exposure to computers used them mostly for word processing purposes and games, rather than using the computers to solve mathematical problems or to do programming. These findings are consistent with the U.S. Commerce Department report that the racial gap between technology “haves” and “have-nots” has not decreased.

2. Biases in Early Socialization

The under-representation of minorities in IT-related fields at the undergraduate level at UNM is at least in part inherited from the bias in early socialization both at home and in the school system. These students differed in their experiences from white and Asian students on family values, social expectations, and teachers’ direction. Under-represented minority students did not view themselves as becoming computer scientists or computer engineers while growing up. They rarely watched their fathers or another close relatives work on a computer at home or had someone who could show them how to tinker with the machine. In high school, teachers identified white and Asian male students as smart in study or as computer experts, thus reinforced white and Asian males’ identification with computers. High school teachers seldom advised under-represented minority students to take courses that would prepare them for IT-related education in post-secondary institutions. The CS and CE departments at UNM also have not made any effort to expose high school graduates to the potentials of IT education. Even white students were somewhat ignorant about CS and CE education at UNM. Asian students considered themselves strong in mathematics and sciences, and thus viewed CS or CE degrees as a natural choice for them. These findings are consistent with research on minorities in science and engineering that they are still prevented from achieving success because of barriers built into the society and educational institutions.

3. Self-Doubts in Mathematics and Computing

Interviews revealed that under-represented minority students differed in on self-confidence about their computing and mathematical skills, as well as logical thinking from the white and Asian students. They did not have any anxiety about mathematics and computing, but held less-positive attitudes toward these subjects than did white and Asian students. Many under-represented minority students did not view mathematics as their strongest subject in high school. They also felt that their high school did not prepare them well in mathematics, logic, and reasoning. Some of them believed that at UNM they had to prove themselves to the teacher every time they took a mathematics, science, or computing course. Even though UNM is a minority-serving institution, many under-represented minority students felt that their teachers are mostly used to working with white and Asian students who are considered smart. Thus, many felt inadequate as they compared themselves with white and Asian students. This is not surprising since under-
represented minority students have had less access to computer technology, came from high schools with limited resources and less well-prepared teachers, and belonged to a lower socioeconomic class. Still, most under-represented minority students had been doing quite well in their courses, receiving A or B grades. The finding of this gap between actual and perceived abilities in mathematics and computing is in contrast to the generally accepted view that under-represented minority students are excluded from science and engineering education because of their lack of mathematical skills.\textsuperscript{7,12,13}

4. Acquiring a Taste for a Geek Field

All students, of both minority and non-minority backgrounds, had similar impressions about computers and the typical CS or CE student. They believed that good CS and CE students are immediately hooked to computers, once they are exposed to them. They are also super smart when it comes to hacking. They handle the demanding CS and CE curricula without as much effort. Their lives center only on the computer since they sit in front of the computer all day and sleep near it. They have no other identity than being a computer scientist or a computer engineer. Most under-represented minority students, however, indicated that they do not match/fit this stereotype. Many white students talked about their early exposure and intrinsic interest in computers as the main reason to major in CS or CE. Under-represented minority students, on the other hand, decided to major in CS or CE due to beliefs in secure employment and high pay. Asian students also cited such pragmatic factors. These findings differ from those studies, which find interest as the single most important factor in retaining students in the technical fields.\textsuperscript{11}

Under-represented minority students in CS and CE were also interested in activities other than CS or CE such as sports and cultural events, which are valued highly at UNM. They also viewed computers as useful tools for society. Many did not have any early exposure, and thus developed interest in CS or CE only gradually. Such findings, like Margolis and Fisher's findings at Carnegie Mellon University, contradict the widely held belief that being a hacker is a prerequisite for a major in CS or CE. This should be an important point in future efforts to recruit students, both from minority and non-minority backgrounds, into CS and CE.

5. Wanting to Leave

Most students find CS and CE as very hard and demanding technical fields. The workload of CS and CE is extremely heavy, with computer programming assignments taking extra amounts of time. They became more demanding for under-represented minority students since they are often non-traditional students. They often entered UNM after working for a number of years to save money for their education. Their average age is 26 years. Without their family’s financial support for education, many have continued to work part-time to support their studies. Some of the CS and CE students are married, have young children, or are single parents. These students find it difficult to keep up with tough and rigorous curricula requirements, as well as looking after children, maintaining a family life, and working part-time. The CS and CE programs are not sensitive to non-traditional students. In order to succeed in these fields, students believe that they need to remain single, without any children and/or jobs. Difficulty in maintaining their course work and balancing that with families and jobs is one of the main reasons students talk about switching their major from CS or CE to information systems. This finding differs from Margolis.
and Fisher\textsuperscript{8} findings that female students feelings of not belonging in the CS field was a major reason for leaving it.

6. Faculty and Teaching

Most minority and non-minority students reported positive experiences with the general atmosphere, faculty, teaching assistants, and support staff. They did feel supported by the faculty and did not voice any complaints against them. Yet, there were some issues with faculty and teaching assistants, which are worth mentioning. Many students felt that the older teachers primarily liked to teach, whereas some younger teachers, instead of teaching, were preoccupied with research, grants, conferences, and workshops. Most students also complained about the competence of foreign teaching assistants, mostly based on their language abilities. A few under-represented minority students also indicated that some of their teachers were unapproachable, impersonal, and intimidating. These students felt that they have to prove to teachers and teaching assistants that they are valuable students. As a result, they did not always ask questions in class or go to teachers or teaching assistants for help in order to create an impression of being smart students. They felt that by asking such questions teachers, teaching assistants, and peers would presume that they do not know the basics. It should be noted that even though UNM is minority-serving institution, CS and CE departments only have one under-represented minority and four females on their faculty; both departments, however, have Asian faculty members. Similarly, very few teaching assistants are under-represented minority students.

7. Racial Issues

Interviews revealed some tension between most minority students who believe race/gender to be a non-issue, and a few who believe race/gender to be an issue, but in a subtle form. None of them had horrible stories from their own or from other minority students' experience about faculty or teaching assistants. Some faculty members, as well as foreign teaching assistants, were considered out-dated in their thoughts and therefore showed some insensitivity; however, minority students did not think that there was any intentional discrimination. Such findings support earlier studies, which found little overt racial/gender discrimination against minority and female students by white male faculty\textsuperscript{11}. Nonetheless, many under-represented minority students did talk about some students who were disrespectful towards them and yet faculty and teaching assistants ignored this. These seem largely to have been unkind remarks and jokes mostly directed at female students by some of the male students. It is important to point out that in this study classroom observations were not carried out; the study relies solely on the students reporting of negative experiences with faculty and teaching assistants. Lack of perception of direct discrimination may also be because UNM as a minority-serving institution is favorable to minority and women students and that large ratios of Hispanic students in many classes minimize negative experiences.

Concluding Remarks

This paper reports some of the findings from the field study conducted at the UNM under a grant from the Sloan Foundation. It shows that some under-represented minority students have been
Taking advantage of opportunities available in IT by pursuing education in CS and CE against all odds. One way to recruit underrepresented minority students is to educate high school teachers in understanding that computer literacy is similar to English and mathematics. High school teachers need to be trained in which basic introductory courses in computing at high school level should be included in their curriculum. Another step would be to specify clearly in admission policies that no prior experience is required to enter the CS or CE program. To make the general environment more minority student-friendly at UNM, faculty could be educated about the types of attributes that create the stereotypes about CS and CE. To deal with the confidence problem of under-represented minority students, advisors could clarify that students do not have to measure themselves against other students’ performance. These departments could create a support system or additional instructional programs so students with varying levels of experience and/or time commitments could get the help they need. By incorporating concerns of diverse student populations, CS and CE programs at UNM could open the doors to a much broader audience.

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