

Integrative Computing Education and Research: White Paper

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1 Challenges

In seeking to identify challenges faced by computing faculty today, several questions come to mind. How do we get recruit undergraduates and retain them, especially women and diversity students? How do we cope with the rapid changes in the computing field and heavy work load for faculty? What qualities, abilities, and skills are important for the long-term success of our graduates, how do we enable students to develop these qualities, and how do we evaluate our success in doing so? What does this imply for the qualities needed by our faculty, and how can we develop faculty members toward growth in these qualities?

Building community and personal relationships in a computing program are key in attracting and retaining students, particularly under-represented students. These relationships include student/faculty, student/student, and student/community. Vincent Tinto[6] lists six principles that govern successful retention programs; the second is reaching out to make personal contact with students. Carol Gilligan[2] makes the argument that women see a world comprised of relationships, and that female identity is centered in relationships. Women in a technical field have a high need for support and encouragement. Many under-represented students do not consider computing because they do not know about the field; an approach to recruiting from the personal perspective, through phone calls and individual meetings, can be beneficial.

Pursuing inter-disciplinary connections in our computing programs can lead to expanded recruitment and increased diversity in our student population. Female students in particular tend to be highly interested in exploring connections between computing and other fields. “For most women students, the technical aspect of computing are interesting, but the study of computer science is made meaningful by its connections to other fields” [4]. Inter-disciplinary connections can help to combat the “geek” image and the notion that a career in computing means sitting in front of a computer all day, both factors that serve to drive prospective students away from the field.

Rapid changes in our field cause great difficulties for faculty who must continually update curriculum, modify courses, and keep abreast of changes in our research area. This leads to high faculty workloads and reactive, rather than proactive, leadership. Many computing faculty have limited background in computer science (having done schooling in other areas such as math) and/or inadequate preparation for teaching.

The question of the skills, abilities, and talents we want our graduates to exhibit is a moving target as the field changes. However, the importance of teamwork and group communication skills in modern computing has been well documented by practitioners and scholars. Other desirable qualities include creativity, diligence, self-discipline, confidence, cooperation, leadership, organization, attention to detail, inter-disciplinary thinking, abstract reasoning, logical thinking, analytical reasoning, algorithmic thinking, originality, visionary thinking, cross-cultural understanding, linguistic ability (both natural languages and computer languages), decision-making ability, reliability, initiative, being able to interact with others, being able to get things done, completing tasks on time, oral communication, written communication, and a strong work ethic. This list suggests an emphasis on development of the “whole person.” Related to this is the question of desirable qualities for our faculty, so that they can be models to students, and how to develop and foster those qualities in faculty.

2 Strategies and Models

Building Community There are a number of ways that we as departmental faculty can foster a sense of community. Invite students to faculty homes regularly for various activities. Institute regular departmental dinners in the dining commons (including both students and faculty). Make students aware of the activities and accomplishments of their peers by making announcements in class and at social events. Attend student activities such as sporting events; musical, theater and dance performances; and social dances.

Establish a support group to provide mentoring and encouragement to female students, led by faculty. They can have fun together and discuss pertinent issues such as academic confidence and feelings of inadequacy, to which female students seem particularly prone. Encourage female students to apply for scholarships to attend the Grace Hopper Celebration of Women in Computing, and to have a faculty member attend along with students. This can be a wonderful time of growth for students, and can spark an interest in attending graduate school.

Fostering Interdisciplinary Connections To encourage and facilitate inter-disciplinary study, we can offer computing students more options for combining computing with studies in another field. A number of

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institutions have created inter-disciplinary programs[1, 5, 7]. For example, Westmont provides sample programs to pursue a degree in computer science with an emphasis in business/management information systems, art/graphics, computer engineering, computational mathematics, human-computer interaction, cognitive science/neuroscience, bioinformatics, artificial intelligence/philosophy, analytical/computational chemistry, music, and secondary education.

Developing the Whole Person A number of strategies can be employed to develop students who are “whole persons.” First, we can involve undergraduate students in research with faculty. This provides opportunities for mentoring and relationships between faculty and students. Encourage undergraduates to co-author papers with a faculty member and present work at research conferences. Traveling as a small group away from campus has a profound impact on building relationships and forming community.

Hold a day-long or overnight departmental retreat, in which classes are canceled and students and faculty go together to a location off campus. Possible activities include discussions regarding ethical issues, seminars on applying to graduate school and preparing for job interviews, and panel discussion led by students.

Emphasize a group lab environment, where the communal aspects of learning may be fostered. Organize paired study programs in which advanced students serve as mentors to beginning students. Emphasize mathematical thinking, logic, and creativity in class sessions, along with group projects and assignments requiring verbal and written communication. Encourage interaction and discussion of ethical and social concerns. Assign students to identify current events and trends in technology, and to present this information to others. Provide opportunities for service learning.

Models for Education A number of possible models for undergraduate education are found in other settings. One model is that of an athletic team, in which players train together, perform together, eat together, and travel together. The coach serves as a leader who constantly evaluates players, notices their strengths and weaknesses, and gives private and public recognition for excellence.

A second model is that of graduate school, or freshman/sophomore seminars, in which small groups of students work closely with a faculty member. This might include small classes or seminars in which discussion and interaction is emphasized, hands-on experiences are provided, and the student-faculty relationship resembles that of an apprentice or mentoring situation. Students might also live together as cohorts.

Another possible model is that of service-learning, as exemplified by the EPICS[3] project. This has the advantages of providing real-world experiences, fostering inter-disciplinary interactions and group work, and helping students to get outside themselves and care about their community and world.

Faculty Qualities and Development In order to be effective in developing the whole student, we need faculty members who model this wholeness of life and share it openly with students in mentoring and class situations. Faculty should be encouraging to students who lack confidence or who are struggling, and provide both high expectations and high support. They should model effective people skills by developing good rapport with the students. The faculty hiring and tenure process should consider these qualities.

We need to recognize and compensate for the unique challenges presented by a field that is moving so rapidly. Possible strategies include reduced teaching loads for computing faculty as well as continuing education and seminars that overview new trends and advancements. Students can also serve as resources to faculty members by assisting in keeping up with current technologies.

Additionally, we need to provide faculty training (at the national, regional, and local level) in effective and innovative teaching strategies, such as how to foster student interactions, lead discussions, develop student thinking skills, make effective use of instructional technologies, engage students in ethical discussion, and foster group and communication skills.

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