4

This chapter presents findings from interviews with female community college students in science, technology, engineering, and mathematics fields regarding their learning experiences, interaction with faculty, and educational and career aspirations.

Broadening Female Participation in Science, Technology, Engineering, and Mathematics: Experiences at Community Colleges

Soko S. Starobin, Frankie Santos Laanan

Over the past few decades, community colleges have helped increase the representation of female and minority students in the fields of science, technology, engineering, and mathematics (Brazziel and Brazziel, 1994; Starobin, 2004; Starobin and Laanan, 2005). These institutions provide educational and vocational opportunities for students through technical education, academic transfer to four-year colleges and universities, remedial, continuing education, and community service (Cohen and Brawer, 2003; Laanan, 2003). The nation's community colleges enroll over 10 million credit and noncredit students, which include more than 57 percent of female students and 38 percent of minority students in the student population pool (National Center for Education Statistics, 2003). Given a substantial percentage of racial and ethnic minorities and women enrolled in community colleges, this pool of individuals serves as a potential group to fulfill the nation's science, technology, engineering, and mathematics (STEM) workforce needs.

Federal Initiatives for Broadening Participation

Federal agencies, such as the National Science Board (2003) and the National Academy of Engineering (2005), have recognized the role of community colleges in increasing workforce competency. The global market has

WILEY InterScience® DISCOVER SOMETHING GREAT

NEW DIRECTIONS FOR COMMUNITY COLLEGES, no. 142, Summer 2008 © 2008 Wiley Periodicals, Inc.
Published online in Wiley InterScience (www.interscience.wiley.com) • DOI: 10.1002/cc.323

shifted from a demand for low-wage, low-skilled workers to a need for high-tech, high-skilled occupations. Community colleges have and will continue to provide opportunities for citizens to acquire new skills and become technologically competent through career and technical education programs and STEM education. The National Science Foundation (NSF) has played an important role as well through increasing funding directly to community colleges, from approximately $7 million in 1993 to over $35 million in 1999 (National Science Foundation, 2001). NSF-funded programs such as STEM Talent Expansion Programs (STEP) and Advanced Technological Education (ATE) Programs specifically support implementation strategies that have led to an increase in the number of community college students studying in STEM, transferring to four-year institutions, and graduating with a STEM baccalaureate degree. These programs are strongly encouraged to develop support services and programs that increase participation among traditionally underrepresented student populations: low income, ethnic and racial minorities, persons with disabilities, and women. One of the purposes of ATE programs is to "improve the educational opportunities of postsecondary students by creating comprehensive articulation partnerships between 2-year and 4-year institutions" (National Science Foundation, 2001, p. 1).

Transfer Function in Community Colleges in STEM Education

Community colleges serve as a stepping-stone for underrepresented groups that otherwise never thought of studying or pursuing STEM-related fields (Laanan, 2001; Starobin, 2004). In a study using the 2001 National Survey of Recent College Graduates, Tsapogas (2004) found that more than 40 percent of science and engineering bachelor's and master's graduates attended community colleges at some point in their educational paths. These graduates were more likely to be Hispanic, African American, American Indian, or Alaskan native; older than traditional-age students; and with parents with lower educational attainment. Tsapogas also found that female science and engineering students are more likely than male graduates to have attended community college, especially among graduates who are married and have children in the household. Tsapogas concluded that community colleges are important institutions in the educational lives of science and engineering graduates. Flexible schedules, low tuition, proximity to jobs, and open access admissions make community colleges attractive to a diverse student body, especially female graduates "who are attempting to manage families, education, and sometimes, jobs" (p. 6).

To date, little research has focused on women enrolled in community colleges and their decision to pursue a STEM baccalaureate degree (Starobin and Laanan, 2005). A study conducted by Starobin (2004) argues that receiving encouragement from individuals at home and school helps female students in STEM programs develop their self-concept. These individuals

can be faculty, counselors, advisers, friends, and family members. Starobin (2004) also identified a need for additional studies to examine female students in STEM at community colleges by applying qualitative research inquiry. To fulfill the void in the literature, this chapter presents findings from interviews with female community college students in STEM fields regarding their learning experiences, interaction with faculty, and educational and career aspirations. It also discusses implications for practice and policy to facilitate female participation in STEM.

Exemplary Practices: Two Tales

The study examined here reports on the second-year efforts of a dissemination project to increase participation among female students in STEM fields. The project was designed to develop media presentations that educate the public and college students about the pathway to a STEM baccalaureate degree, create a STEM transfer guide for prospective students attending two-year colleges, and build a Web site for academic counselors, transfer center coordinators, students in two-year colleges, business and industry, researchers, policymakers, and the public.

To achieve the study objectives, the project investigators identified and then studied exemplary transfer programs that increase participation among female and minority students in STEM. Thus, the purposes of this study were to understand how gender influenced learning experiences among female students in a preengineering program at a community college; provide students the opportunity to reflect on and share their academic and personal experiences; and identify factors that help female students transfer from a community college to a four-year university in engineering.

Guided group interviews were conducted at Highline Community College (HCC) and Seattle Central Community College (SCCC), both part of the Northwest Engineering Talent Expansion Partnership (NW-ETEP), which provides an opportunity for every student who is motivated and prepared to earn an engineering degree in Washington State. One of the objectives of the NW-ETEP is to increase the number of women who earn engineering degrees by providing support programs. Components of this program include a comprehensive team comprising community college faculty and student services providers; an on-site community college coordinator; and academic support, major and career exploration, and transfer assistance.

Highline Community College. The main HCC campus is located twenty minutes south of downtown Seattle. HCC, which enrolled approximately fifteen thousand students in 2005–2006, is one of the state's largest postsecondary institutions. It offers associate degrees that provide preparation for transfer to four-year institutions along with associate of applied science degrees and certificate programs. More than 40 percent of students indicate that their intent is to transfer to four-year institutions. With regard to student demographics at HCC, more than 60 percent of the students are female, and

approximately 50 percent are ethnic minority. As a result of the NW-ETEP initiative, HCC provides academic and support services developed by the on-site coordinator and faculty members. HCC also has dedicated classroom space for NW-ETEP participants for academic and social activities.

Seattle Central Community College. Located in the vibrant Broadway Street area, Seattle Central Community College (SCCC) enrolled more than seventeen thousand students during the 2005–2006 academic year. Students at SCCC are significantly more diverse than the city of Seattle: 40 percent are ethnic minorities, and 56.5 percent are female. SCCC emphasizes preparation of students to transfer to a four-year institution by providing well-articulated associate degrees, such as associate of art, associate of science, and associate of applied science-transfer degrees. NW-ETEP participants at SCCC can receive academic and social support from the on-site coordinator at the College Transfer Center as well as from faculty members.

Reflections and Experiences of Female STEM Students

The guided group interviews consisted of three female students who were invited by faculty and program coordinators of NW-ETEP programs at HCC and SCCC. The researchers requested that the program coordinators invite female engineering students who are planning to transfer to a four-year institution. Female facilitators guided group interviews to create a safe and comfortable space for the participants to express their opinions. The questions that guided the interviews addressed such topics as individuals who contributed to the students' choice to pursue an engineering degree, programs and services at the community college that helped students prepare for transfer and make career decisions, and academic environments that made students comfortable and uncomfortable. Data from the interviews were tape-recorded and transcribed. The researchers reviewed and coded the transcripts to identify recurring themes and opinions.

In the following section, highlights of the guided group interviews are presented to capture female students' self-expressions and reflections with regard to their personal and academic experiences.

Wish I Knew Before. A lack of social and academic support for female students to pursue STEM fields can impede their academic and career aspirations (Starobin and Laanan, 2005). Female students also tend to believe in the long-standing stereotype that men are good in math and women are stronger in humanities (Seymour and Hewitt, 1997). Many of the participants of the group interviews said they wished someone had told them earlier that they could study engineering:

> Nobody had ever suggested or even put the thought in my mind that I could actually do something that big, that grand, and so after investigating it I thought, Oh, okay, might as well. So, that is how I got into engineering. I sure wish someone had said something when I was younger because being older

> it is harder. I just missed so much, you know, I think if I had been encouraged when I was younger. [Lori]
>
> I wish somebody had told me about it [engineering] earlier. Until I took physics I did not know, you know, I did not know engineers existed. I did not know who designed those buildings. . . . I think if somebody had communicated to me personally in middle school in one of my math classes or science classes, I think I would have probably been thinking about it [engineering] a lot earlier. [Eleena]
>
> For me, it was my dad. He was always a good example, but I never thought I was good enough with math to become an engineer, so for years and years, I decided not to do it. I talked to my teacher who was Rebecca, and she was actually very encouraging that if I just stuck with it, I would probably do pretty good. [Celeste]

It is noteworthy that these students never mentioned that they did not like or have a fear of studying math or science. Furthermore, most of them had some positive experiences in studying math and science in middle school. Their comments affirm that a lack of support, encouragement, and reinforcement harms females' intent to study engineering. One female student passionately claimed, "I just wish someone had planted the seed and mentioned that you know, engineering is possible, and you can do this . . . just that little statement just like changed my world basically."

All of these comments also confirm that these students vividly remembered that moment when a faculty member or counselor told them that they could study engineering and become an engineer. Such positive personal encounters and communication with faculty and counselors consistently emerge as a vital element for success among female students in engineering.

See a Clear Pathway. Almost all participants agreed that advising from faculty and program coordinators was critical in the decision to continue their engineering study and pursue transfer to a four-year institution. Some were quite surprised by the support that they received from their faculty. At HCC, students who are enrolled in Engineering 101 learned about required courses for transfer, financial aid, and support services available for them. During the course, students develop a two-year plan to map an academic path to transfer. When students were asked about programs and services that helped them to prepare for transfer, Lori responded, "Without the two-year plan I would be one of those perpetual students because I always like to add an art class each quarter, and take a Web design class this quarter but the two-year plan keeps me focused. . . . . The two-year plan saved me with financial aid, too. "

Without a clear understanding and guidance, it is difficult to stay focused and not get behind in the rigorous courses typical of engineering programs. Another student agreed: "Having things planned out for the right

quarters, you can get things done on time." In addition, students begin to develop skills to survive challenging courses and sustain good grades. One student, Erin, said, "You can also look at and determine which classes you take when and how best to break it up like as far as, Okay, do I want to take chemistry, or do I want to take physics, or do I want to take an elective here?"

Seeing a clear pathway to transfer can be critical for female students. Once they learn not to be preoccupied with or afraid of their immediate challenges, they begin to apply the same principle to their content learning. Erin said, "I love that as well seeing all the little dots connected, seeing how things relate to everything, being able to take something from calculus class and throw it into my engineering classes and come out with something that works, it is very cool."

It is evident that content learning also serves as a contributing factor in their persistence.

Leadership Grows in a Unique Community. One of the most significant findings in this study was that community colleges provide a unique learning culture and environment for female students in engineering. Interestingly, a plethora of literature documents the negative learning culture and environment at four-year research institutions for female students in STEM fields (Lovitts, 2001; Sax, 1994; Seymour and Hewitt, 1997). However, when students were asked to reflect on their gender-conscious opinions on the learning environment at their community college, their responses portray the unique culture and environment that the college creates, which appears as a contrast to the culture and environment of four-year institutions found in past studies:

> You know, we have all different people from all around the world here, and it is just such a global community. [Brittney]

Unlike the traditional STEM academic culture that four-year research institutions create, the learning environment at a community college directly reflects the community with regard to political orientations, diversity, and lifestyle. Such a diverse culture at the community college may help female students focus on their engineering studies rather than being conscious of their gender. These students say that once they get to know their classmates, regardless of their gender, they feel comfortable in their science and engineering classes. One student, Patricia, described how she sees herself in such surroundings: "For me, I almost always end up managing the project. I feel like the mommy a lot, so we have always split up pretty equally [between males and females]. Like I have had the same group in statics and dynamics—we meet, and I always make sure they are doing their part, and they are coming to the meetings, and they know what they are doing. So, I feel more like the manager of the group."

At HCC, engineering students participate in the annual human-powered paper vehicle competition: they are required to design, develop, and construct a vehicle that is made out of 90 percent paper and 10 percent

other materials and powered by a human. Erin reflected on the experiences in the project: "I am glad that I finished that [competition] because it just was so awesome to go there and have it work. May and I, the other girl on the team, really bonded because we had to fight through this thing, and it really made me step up and be a leader. Before that I was kinda like just going along with them [males] and doing what they wanted and stuff like that."

Such a unique learning culture and environment encourages female students to do well in the classroom and play a leadership role in classroom activities and assignments. Many female students were surprised to realize they had an ability to lead a group and project among their male classmates. And those who took a risk of becoming a leader began to develop confidence and self-esteem.

Believing Becomes Persistence. With a sense of confidence and self-esteem, female students in the group interviews described their attitudes toward advanced math courses and readiness for transfer to a four-year institution. They wanted other female students to know about their experiences:

> If engineering is something that you want to do, you can just work hard. Everyone works hard. It does not matter if it comes to you more easily than other people. . . it is training. I mean you are not born a fast runner or good athlete. That is something you work on to do. If you want it, go for it. [Celeste]

> It does not matter if you are not so good in math; you can get better, you can practice, talk to people. And study groups are huge, very important, very important. [Erin]

> Scary subject [math], but it is like any other skill. You just have to, you have to learn it. . . . I mean like writing, some people can write books and novels, and I can't. You know, it is a skill that you have to learn. [Lori]

These comments indicate that the female students' attitudes toward advanced math courses are positive. Most important, many of them take the responsibility to work hard and do well. None felt they were less capable of learning advanced math than their male counterparts. Confidence and self-esteem clearly can be cited as an outcome of the NW-ETEP program for these students as they prepare for transfer to an engineering program at a four-year institution:

> I feel like I can go on to the university. I feel like I can do it because I have gone through you know, so many different opportunities that have helped my mentality, just changing that way here at Highline. [Eleena]

> I am a little scared honestly because it is going to be such a big step. It is such a transition, but I think I am going to go in there, and I am gonna hold my own. And I am gonna do well, I am gonna do good things, definitely. [Erin]

As these female students conveyed their confidence and readiness to transfer from a community college to a four-year institution, the positive outcomes of the NW-ETEP program were confirmed. NW-ETEP successfully fostered these students' confidence and academic excellence in preparation for transfer. The researchers were convinced that with the support of the team faculty, student services providers, and an on-site coordinator, these female students have been empowered to thrive and pursue their aspirations to obtain a baccalaureate degree in engineering.

Implications for Practice, Policy, and Future Directions

This investigation pointed out several implications for practice for those interested in creating a learning environment that helps female students as they pursue preengineering programs.

Build a Supportive Environment with Key Constituents. According to most of our female participants, it is critical to find faculty, advisers, or counselors to provide guidance, support, and encouragement at an early stage and throughout their program of study. These key constituents offer critical support to female students as they build their skills and confidence toward successful transfer. Students also find support in fellow students. Community colleges can therefore provide assistance and opportunity for students to build their learning community. The curriculum can be arranged to encourage students to take courses in a sequence so they can build an academic community that supports and nurtures their success. Students often noted the importance of study groups to their academic success. Building the academic community as well as study groups is particularly important for community college female students who have jobs, family responsibilities, and other challenges. Most important, key constituents who help female students are often found in strong academic community and study groups.

Show a Clear Pathway to a Baccalaureate Degree. An introductory course such as Engineering 101 at HCC provides students with the information, skills, and resources they need to navigate the transfer system, course requirements, financial aid, and other factors that lead to successful transfer. To deliver such practices, institutions and programs must value and recognize this curricular content and commit resources to its development and delivery. Once students understand how to navigate their pathway to a baccalaureate degree, they begin to feel comfortable with and confident in overcoming their personal and academic challenges. The group interview participants said that it is critical for female students to believe that they can meet academic challenges. Their positive attitudes toward advanced courses lead to self-confidence and self-esteem.

Send Positive Messages Early. Virtually all students in this study mentioned the importance of faculty and counselors who encouraged them to pursue engineering. Most did not receive these messages at home and

wished someone had influenced them sooner. The message they need to receive is simple: "You can do it."

A striking finding from this study was that the majority of the group interview participants wished someone had told them earlier that they could study engineering. To create opportunities for community college female students to receive positive messages, the colleges can partner with four-year institutions to develop a bridge program or summer research program for female students so they can experience the academic environment at a four-year institution. In addition, community colleges can arrange mentoring programs in business and industry for female students to meet female engineers and learn about their career opportunities.

Conclusion

This study provides policy implications for increasing the number of female STEM baccalaureates and beyond. At the National Science Board Workshop, policymakers were encouraged to understand the enormous range of pathways that students take between community colleges and four-year institutions. Furthermore, the National Academy of Engineering urges that "four year schools should accept the responsibility of working with local community colleges to achieve workable articulation with their 2-year engineering programs" (2005, p. 2).

Community colleges as well as their partner four-year institutions are encouraged to seek financial assistance from foundations or agencies such as the National Science Foundation to develop and deliver programs and services to encourage female students to pursue studies in STEM fields. Key to the success of these programs is an on-site coordinator who serves as the conduit and facilitator of the program and its students, faculty, staff, and partners. Resources obtained through such initiatives allow community colleges to develop partnerships not only with four-year institutions for transfer opportunities but with business and industry for students who seek career opportunities. Community colleges can also develop partnerships with K–12 schools to encourage young girls to pursue their studies in STEM fields.

The female students in the group interviews clearly noted the need for both two-year and four-year institutions to strengthen partnerships so that programs and services can be developed to offer positive learning experiences and increase the participation among female students in STEM fields to obtain a baccalaureate degree.

References

Brazziel, W. F., and Brazziel, M. E. "Minority Science and Engineering Doctorate Recipients with Junior and Community College Backgrounds." *Community College Journal of Research and Practice,* 1994, *18*(1), 71–80.

Cohen, A. M., and Brawer, F. B. *The American Community College.* (4th ed.) San Francisco: Jossey-Bass, 2003.

Laanan, F. S. "Transfer Student Adjustment." In F. S. Laanan (ed.), *Transfer Students: Trends and Issues*. New Directions for Community Colleges, no. 114. San Francisco: Jossey-Bass, 2001.
Laanan, F. S. "Degree Aspirations of Two-Year College Students." *Community College of Research and Practice,* 2003, *27,* 495–518.
Lovitts, E. B. *Leaving the Ivory Tower: The Cases and Consequences of Departure from Doctoral Study*. Lanham, Md.: Rowman and Littlefield, 2001.
National Academy of Engineering. *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*. Washington, D.C.: National Academies Press, 2005.
National Center for Education Statistics. *Digest of Education Statistics: 2002.* Washington, D.C.: U.S. Department of Education, 2003.
National Science Board. *The Science and Engineering Workforce Realizing America's Potential*. Washington, D.C.: National Science Foundation, 2003.
National Science Foundation. *National Science Foundation Support for Two-Year Colleges, Fiscal Years 1997–1999: A Report of the Division of Undergraduate Education*. Washington, D.C.: National Science Foundation, 2001.
Sax, L. J. "Predicting Gender and Major Field Differences in Mathematical Self-Concept During College." *Journal of Women and Minorities in Science and Engineering,* 1994, *1*(4), 291–307.
Seymour, E., and Hewitt, N. M. *Talking about Leaving: Why Undergraduates Leave the Sciences*. Boulder, Colo.: Westview, 1997.
Starobin, S. S. "Gender Differences in College Choice, Aspirations, and Self-Concept Among Community College Students in Science, Mathematics, and Engineering." Unpublished doctoral dissertation, University of North Texas, 2004.
Starobin, S. S., and Laanan, F. S. "Influence of Pre-College Experience on Self-Concept Among Community College Students in Science, Mathematics, and Engineering." *Journal of Women and Minorities in Science and Engineering,* 2005, *11*(3), 209–230.
Tsapogas, J. *The Role of Community Colleges in the Education of Recent Science and Engineering Graduates*. Washington, D.C.: National Science Foundation, 2004.

SOKO S. STAROBIN is a clinician faculty member in the department of educational leadership and policy studies at Iowa State University in Ames, Iowa.

FRANKIE SANTOS LAANAN is associate professor in the department of educational leadership and policy studies at Iowa State University in Ames, Iowa.

Copyright of New Directions for Community Colleges is the property of John Wiley & Sons, Inc. / Education and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.