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Frankie Santos Laanan, Iowa State University
Frankie Santos Laanan is associate professor and director of the Office of Community College Research and Policy at Iowa State University. His research focuses on the role of community colleges in serving as a pathway for women and minorities in STEM.

Dimitra Jackson, Iowa State University
Dimitra Jackson is a doctoral student and research associate in the Office of Community College Research and Policy at Iowa State University. Her research interests focuses on underrepresented students in STEM fields.

Soko Starobin, Iowa State University
Soko Starobin is assistant professor in the department of educational leadership and policy studies at Iowa State University. Her research focuses on gender issues related to STEM.

Mary Darrow, Iowa State University
Mary Darrow is program coordinator for an NSF funded project focused on the pathway from community college to engineering and doctoral student in higher education at Iowa State University.
Educating Future Engineers: Role of Community Colleges

Abstract

This study is based on the efforts of a dissemination project to increase participation among female students in STEM fields entitled, Pathway to a STEM Baccalaureate Degree: Research Trends, Exemplary Practices, and Successful Strategies, funded by the National Science Foundation (Award #0507882). Having reviewed numerous support programs that are currently funded by NSF to increase numbers of traditionally underrepresented student population in STEM fields, the authors examine exemplary transfer programs that are specifically aimed to increase participations among female students in STEM fields. The purposes of this study are: 1) to understand how gender influenced learning experiences among female students in pre-engineering program at a community college; 2) to provide students the opportunity to reflect on and share their academic and personal experiences; and 3) to identify factors that facilitate female students to pursue transfer from a community college to a four-year university in engineering.

The analytical framework used for this study is based on the ground theories from previous studies on women in STEM fields. A plethora of literature documents negative learning culture and environment at research four-year institutions for female students in STEM fields (Lovitts, 2001; Sax, 1994; Seymour and Hewitt, 1997). A recent study of engineering students at highly ranked West Coast research universities, Vogt, Hocevar, and Hagedorn (2007) found that female students reported greater discrimination. Guided by this framework, this study intends to better understand students’ reflections on their gender conscious opinions on the learning environment at their community college, specifically the unique culture and environment that the college creates to facilitate their success.

Interviews were conducted in spring 2007 at three community colleges with faculty and students. The colleges included: 1) Highline Community College (HCC); and 2) Seattle Central Community College (SCCC) in Washington. HCC and SCCC are part of the Northwest Engineering Talent Expansion Partnership (NW-ETEP) with other partner Washington postsecondary institutions to provide an opportunity for every student who is motivated and prepared to earn an engineering degree in the State of Washington.

The interviews consisted of nine community college faculty, administrators, and program coordinators. The researchers requested the program coordinators to invite specifically 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. Data from the guided group interviews were tape recorded and transcribed. The researchers reviewed and coded the transcripts to identify recurring themes and opinions.

This research paper presents findings from interviews with female community college students in STEM fields regarding their learning experiences, interaction with faculty, and educational and career aspirations. The authors discuss implications for practice and policy to facilitate female participation in Science, Technology, Engineering, and Mathematics (STEM).
Introduction and Background

The nation’s public two-year colleges play a critical role in providing access to education beyond high school. Referred to as community colleges, these institutions are comprehensive in nature and offer diverse curriculum including developmental education, liberal arts, career and technical education, and lifelong learning (Cohen & Brawer, 2008). The transfer function, in particular, provides students with the opportunity to pursue the first two-year of their general education requirements in pursuit of the baccalaureate degree. Transfer and articulation policies are important to students who begin their education at a community college. Depending on the state in which the student resides, the transfer and articulation policies will dictate the specific roadmap for students to complete the transfer requirements and prerequisites for their major at the four-year institutions.

The role of community colleges in preparing future scientists and technicians has received national attention. Specific to the education and training of future engineers, this role is not fully understood by the public. According to Tsapogas (2004), community colleges are sectors that provide many individuals with educational experiences, especially in the fields of science and engineering degrees. In a study conducted in 2004, he found that over 40 percent of recent science and engineering graduates attended community college at some point in their educational pathways. Tsapogas (2004), among the 1999 and 2000 science and engineering (S&E) graduates, almost half (or 44%) had attended a community college sometime during their postsecondary education career prior to graduating.

Women in STEM

The literature on women in STEM highlights the not only the underrepresentation of this population but also the urgent need to increase the number of women pursuing STEM areas of study. While the percentage of women enrolling and obtaining bachelor degrees is at an all time high, the percentage of individuals pursuing degrees in STEM areas is not comparable. In 2003-04, “women represented 57% of undergraduate degrees awarded across all fields in higher education; but only 25.1% in computer and information sciences, 21.4% in physics, and 20.5% in engineering” (Fox et al., 2009, p. 334).

Current existing literature has attempted to identify contributing factors to this underrepresentation of women in STEM disciplines. Among the identify factors are academic preparation, lack of roles models, hidden curriculum, and chilly classroom environments have all been discussed in the literature on women in STEM (Blickenstaff, 2005).

Faculty, Staff, and Administrators

Faculty, staff and administrators play an essential role in the lives and academic journeys of women aspiring to pursue degrees in STEM majors. These individuals are not only able to influence and create environments where female students feel comfortable but they are also in positions to provide the necessary resources for student success. The lack of women in STEM areas ranges number of reasons including “chilly” classroom climate (Hall & Sanders, 1992), a
lack of critical mass (Ferreia, 2002)\textsuperscript{7}, and a lack of role models (Etzkowitz, Kemelgor, Uzzi, & Neushatz, 2000)\textsuperscript{6}.

Faculty, Staff and Administrators are in excellent positions to respond to the factors that contribute to the underrepresentation of this population. According to Ashby (2006) “university officials, researchers, and others cited the availability of mentors as having a large influence on the decision to enter STEM fields and noted that many students with STEM degrees find employment in non-STEM fields.” (p. 9). Mentoring is referred to by some researchers as “developmental relationships” (Crosby & Blake-Beard, 2005, p. 419), and is cited as being an essential to the increase of the participation of women in science. Mentors provide support and guidance for females in STEM areas and can consist of instructors, role models, employers and advisors (Chang, 2005, p. 770).

\textbf{Initiatives}

Several initiatives have been developed to address women in STEM. Fox, Sonnert and Nikiforova (2009) examined different programs aimed at assisting undergraduate women to succeed in science and engineering degrees. Researchers assert that the most successful programs “defined the problem/issue of undergraduate majors in science and engineering more comprehensively, with greater awareness of the structural antecedents of the underrepresentation of women” (Fox et al., 2009, p. 340). Further, these programs emphasized interpersonal communication “but in combination with resourcefulness, collaboration, and outreach that connect the program with administrators and others in the environment beyond the students” (Fox et al. 2009, p. 343).

This study is based on the second-year efforts of the dissemination project to increase participation among female students in STEM fields entitled, \textit{Pathway to a STEM Baccalaureate Degree: Research Trends, Exemplary Practices, and Successful Strategies}, funded by the National Science Foundation (NSF). Having reviewed numerous support programs that are currently funded by NSF to increase the numbers of traditionally underrepresented student population in STEM fields, the authors examine exemplary transfer programs that are specifically aimed to increase participation among female students in STEM fields. The purposes of this study are: 1) to understand how administrators and faculty describe their role in increasing the participation of underrepresented populations in STEM fields; 2) to understand how administrators and faculty perceive the role of NSF in increasing the participation of underrepresented populations in STEM fields; and 3) to understand the challenges of 2-year and 5-year collaborations in the above objectives.

\textbf{Theoretical Framework}

The Northwest Engineering Talent Expansion Partnership (NW-ETEP) is a Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP). NW-ETEP is a statewide initiative designed to assist in the increase of underrepresented populations in STEM areas. This study utilizes psychological and sociological theories of organization to explore the organizational identity of NW-ETEP on multiple levels. These levels include the macro level of NW-ETEP as an organization and the micro level focusing on the faculty and staff within NW-
ETEP. Organizational identity focuses on the shared beliefs of an organization and responds to “Who are we, as an organization” (Whetten & Mackey, 2002, p. 394).11

For the purposes of this study, the aforementioned framework will be applied on two levels. The first level takes into account the 2-year and 4-year institutions and the collaboration that exists not only among the two types of institutions but also the collaboration that exists with surrounding high schools. The second level will primarily explore the how the faculty, staff and administrators who are involved in NW-ETEP behave and operate within the larger organization and how they view their role in increasing the participation of women in STEM majors. The theoretical framework used for this study is based on the ground theories from previous studies on women in STEM fields. Partnerships and connections within an institution as well as the partnerships and collaboration efforts external to the institution will be explored. Situating theories of validation, involvement, and collaboration within organizational theories helps one to understand the role NW-ETEP as an organization in increasing the participation of women in STEM majors.

Figure 1: The Conceptual Framework of the Organizational Structure of NW-ETEP.
Background of STEP and NW-ETEP

STEP programs are focused on increasing the number of underrepresented populations in Science, Technology, Engineering and Mathematics (STEM) areas. More specifically, NW-ETEP is a statewide STEP program designed to assist in the increase of women and underrepresented populations in Engineering. NW-ETEP consists of 4 partner Universities: University of Washington, Washington State University, Seattle University and Gonzaga University and 4 partner Community Colleges: Columbia Basin College, Highline Community College, Seattle Central Community College, and Yakima Valley Community. The common vision of NW-ETEP is to provide an opportunity in the State of Washington for every student who is motivated and prepared to earn an engineering degree. For the purposes of this study, the University of Washington, Highline Community College, Seattle Central Community College will be the focus of this study.

Purpose

The purpose of this qualitative study is to understand the role of community colleges in preparing future engineers from the perspectives of administrators and faculty. More specifically, the purpose of this study is two-fold. This study seeks: 1) to understand the role of NW-ETEP as an organization in increasing the participation of women in STEM and 2) to understand how the faculty, staff and administrators of NW-ETEP view their role and the essential components in increasing the women in STEM. NW-ETEP is a STEP program, which is funded by the National Science Foundation (NSF). The STEP site is located in the Pacific Northwest.

Research Questions

The research questions guiding this study include the following:

- What is the role of NW-ETEP in increasing the participation of women in STEM areas?
- How do community college administrators and faculty describe their role in educating and preparing future engineers?
- What challenges, if any, do community college leaders and faculty describe regarding the partnerships between two-year colleges and four-year institutions?

Methodology

A phenomenological approach was employed for this qualitative study. The current study was designed to explore the lived experiences (Creswell, 2007) of faculty members and administrators who are involved in institutions that are a part of the Northwest Engineering Talent Expansion Partnership (NW-ETEP) program. The goal of the NW-ETEP program is to increase the number of underrepresented populations (students of color and women) in engineering programs and to implement strategies to utilize the resources in of all of the state’s engineering programs. The research team conducted face-to-face, semi-structured qualitative interviews with interested participants of NW-ETEP. Qualitative interviews were used to “engage in dialogues and conversations with the participants” (Lichtman, 2006, p. 116).
study seeks to explore how participants of NW-ETEP program view their role and the role of the program in increasing the number of underrepresented populations in STEM fields, more specifically, Engineering. Constructionism suggests that “meanings are constructed by human beings as they engage with the world they are interpreting” (Crotty, 1998). The goals of this investigation included exploration of the phenomenon to allow the involved community college and university faculty and administrators of the NW-ETEP Program to freely present information regarding their personal perspectives of their overall experiences in the NW-ETEP program. An experienced research team assisted the primary investigator (PI) in this research project, both with the initial interview and with the subsequent content analyses of the collected data.

**Participants.** The participants ranged from STEM faculty members, administrators, and project coordinators in participating NW-ETEP community colleges and universities. The participants included three female community college faculty members, 1 male community college faculty member, a project coordinator, a retention specialist, a Dean of Transfer, an Associate Dean of Academic Affairs in the College of Engineering and the Director of Introductory Academic Courses.

**Interviews.** The PI and the research team conducted face-to-face semi-structured interviews with each of the volunteer participants. The participants were prompted with interview questions which allowed the interviewees to talk freely for approximately an hour and a half. The interview protocol consisted of questions that were geared toward the individual’s position at the institution. As the participants described their experiences, the research team posed follow-up inquiries that stemmed from the participants’ previous statements. After the interviews, the research team transcribed the audio-taped interviews into written protocols.

**Data Analysis**

The data analysis was conducted using Crewswell’s (2007) Qualitative Inquiry and Research Design. Copies of each transcribed interview transcript were distributed to the team members. Each of the transcripts were reviewed once without taking notes to provide a “general sense of the information and to reflect on its overall meaning” (Creswell, 2009, p. 185). The second reviewing consisted of coding strategies of the transcripts consisted of highlighting significant statements and quotes in each of the transcripts. The statements and quotes were then clustered into groups according to meaning derived from the significant statements (Creswell, 2009, p. 61). Themes began to emerge from the clusters. Textural and structural descriptions of what the participants experienced and how the setting influenced their experiences were written using the significant statements and themes. Recoding of the themes was conducted when necessary.

**Findings**

NW-ETEP has explicitly defined their focus of increasing the participation of women and underrepresented populations in STEM, more specifically, Engineering fields. NW-ETEP has provided the resources necessary to strategically implement projects and activities geared towards this end. There were many themes that the NW-ETEP participants viewed as benefits. Pursing the right path, Effective Collaboration, Relevant Learning, Building relationships and
Student Engagement results of the efforts of NW-ETEP have all been enhanced as a result of NW-ETEP.

**Pursuing the Right Path**

The transfer process can be confusing and overwhelming for community college students. Understanding the connection between the community college requirements for degrees in Science, Technology, Engineering, and Mathematics (STEM) and university requirements for STEM can be helpful. The faculty at Washington community colleges and universities discuss the importance of ensuring that students are on the right path of pursuing a STEM degree; more specifically a degree in Engineering. The two-year individual advising plan that is designed for each student provides students with a clear outlook on future classes and the needed steps for academic success.

It is important for faculty and community college administration to clearly understand the ultimate goals of each student. Students attend community colleges for many different reasons. Some students attend community colleges for the goal of transferring to a 4-year university while other students desire to pursue vocational educational degrees. Ensuring that students understand that a place lies for them in Engineering is essential.

“I think that there are opportunities for those students as engineers and in some respects I think we were responding to a demand or a supply and demand issue with engineers but we also felt like there were a number of students that had interests in engineering for various reasons who weren’t connecting with the right pathways to get their engineering degrees and while we love to see all students come to the UW and get their engineering degrees, we also know that there are other opportunities for students in other paths to get engineering degrees in the state and what we wanted to do instead of working against those efforts is we wanted to make sure that collectively we worked together so that students understood that there is a place for them if they wanted to get an engineering degree.”

Placing students on the right path is viewed as an essential component of advising.

“I think that’s the most important piece of advising is making sure they’re on the right path from the beginning, there’s nothing more demoralizing than having to start over again.”

Without the clear path, the transfer process can be difficult for students to understand.

“For most of our students the difficulty is understanding the process to get from a two-year to a four-year school and so having a nice system is nice in that it gives us a foundation that it’s not changing.”

Once students have clearly identified their purpose for attending their respective community colleges, it is important to provide each student with a two-year plan that is developed to meet
their individual academic needs. The two-year plan outlines all of the needed classes and will allow the students the opportunity to self-advise.

“... the key thing to student success is we believe that every student gets a two-year advising plan and that we meet with each student individually and develop a plan for their time here at Highline. We say two-year plan. However, it might be three-year plan depending on what level they start. So we try to individually do that with each student.”

“... half of that class [Engineering 101] is devoted to the how do you, I'll say run the gauntlet between here to get to a four-year school. Because the system is good and it's in place, educating students about the system and helping them understand the process which they go through to do that and then out of that we talk about that, out of that we develop a specific two-year plan for the department that they want to go into based on the AST degree and the things that exist.”

“One of those is to create a two year plan which actually maps out every class that students will take through their two years here for their Associate of Science transfer degree. So at any point during their stay here when we ask a student what are you taking next, they should be able to say, I just need to check my two year plan and this avoids a lot of surprises toward the degree or transfer requirements. So very early on the students know exactly what classes they need.”

Effective Collaboration

NW-ETEP had assisted in the creation of a collaborative environment where faculty members at community colleges and universities are able to have a conversation regarding the academic success of all students, more specifically, underrepresented populations. The increase in this population requires the collective efforts of all entities involved.

“Northwest E-TEP is that it’s created an environment where you’ve got baccalaureate institutions and cc’s actively talking about how to increase the representation of underrepresented groups in math, science, and engineering so it gives a place for that discussion to happen.”

“The biggest thing probably is within Washington state is that the community colleges and the four-year schools work very closely together around transfer education.”

“The big objective for us is how do we increase the number of students getting particularly engineering degrees in our state and particularly underrepresented students and we came to the conclusion that it really took more than one institution to sort of make that happen. As a result while we may be able to see some gains at the UW we’re also a fairly oversubscribed school in engineering. As a result, many to most all of our available seats in engineering are filled. We were thinking why don’t we partner with the other engineering schools in the state of Washington State University and the University in Gonzaga and look at where particularly students of color begin their college careers and so we had relationships with cc’s across the state is where our kind of ongoing work. So we looked at the four most diverse cc’s in the state and felt that we could provide
resources at those cc’s and work in conjunction with their faculty and staff and administration to support specifically students, particularly students of color and women that are interested in transferring to our institutions to obtain engineering degrees so our goal was not necessarily to increase degree production at any one institution but to look at the entire state of Washington and the four major engineering producers and see if we might be able to increase the degree production collectively as a system as opposed to just looking at gains of one institution.

Moreover, this collaboration provides knowledge to both community college faculty members and university faculty members that can then be relayed to the community college students. This form of communication informs community colleges and universities about trends, issues and any improvements that will benefit transfer students.

“The liaison role between my students and helping them understand the processes to go to a four-year school it’s not a constant battle between the four-year schools and two-year schools about curriculum, those things don’t happen as curriculum changes come down from the four-year schools we do the best that we can do adapt our classes so that they can transfer.”

“I was thinking that we have this math conference every year that is just it started with a bunch of sleeping bags out at some resort by the mountains with about twelve people and now has blossomed into this state wide it doesn’t have even a name it’s just the Washington state math conference so all cc faculty and four-year folks not in huge numbers show up to where some of these things can be hashed out and just kind of keep abreast of what’s going on with each other, what are the trends, what needs, does anything need to be dealt with we have sessions where we have presenters and things but that’s kind of another informal relationships that I think helps with the transfer issue.

Relevant Learning

Engineering has been viewed as a male dominated area. NW-ETEP has strategically sought ways to increase the participation of women and students of color in the field of Engineering. While speaking with faculty and administrators who are involved with NW-ETEP, the idea of “relevant learning” emerged. Relevant learning has been viewed as proactive way of ensuring that activities and assignments are applicable to the population whom they are serving. When women and students of color are able to positively view themselves in a specific area, such as Engineering, they are more likely to persist. This is shown through recruitment efforts, advising, classroom assignments and projects, in the selection of presentations.

“I think what I’ve noticed is that we try to provide relevant learning to the students so instead of just giving them a formula we show them a formula and describe how it’s used in the real world um and in particular when I say relevant learning we want to reach out to underrepresented minorities and women and so in an engineering class if we’re doing a problem I think instead of maybe showing a racecar we might show something that’s a little more appropriate for women and other people and other interests so relevant learning and another big thing.”
The recruitment strategies have been altered to speak to the values and interests of women. The idea of helping others helps women to connect to the engineering field.

"We have them in the pipeline so what are we doing so first round recruitment is we really changed how we recruit for our program we’re changing it so we’re marketing engineering as a helping profession to show that we can connect that engineers change people’s lives, they provide solutions for people’s lives as opposed to engineers build bridges and build cars uh, and we try to connect to examples that are pertinent um, for instance a good example in Seattle, they were going to rebuild the viaducts it’s a big political, social mess, probably engineers will provide that solution to society to help people get to work and be more effective so how we market engineering is we talk to students that engineers help the world go better right...learning to change our world to impact our world much as the medical profession markets."

When advising students, engineering has been recharacterized as a caring and helping profession. Students are informed on the roles that women play in Engineering and difference women make in the world of Engineering.

"When the ladies or women come to my office and show the interest of sometime concern because this is a man field they kind of worry or are concern and we talk the women science usually is caring, nurture so we talk about what the engineering can help people or can in the field of helping."

"We’ll talk to the students or potential students about what engineers do but we recharacterize science and engineering somewhat into helping how, how engineers help people how engineers make a difference in the world, both on an individual level and a general societal level too. This seems to ring a very strong chord with women in particular. So that’s the one of the big messages that we give them and so we try to provide examples of how engineers help people and what a career might look like and also what an educational path would look like through those..."

Classroom activities and lab environments are viewed as ways to actively engage students in meaningful activities. Students, more specifically women, are allowed opportunities to proactively express themselves and make meaning of the world of Engineering.

"I still don’t ask them to do anything just because. The thing that I was very frustrated with my physics education was that I wasn’t really allowed to put any of myself into it I was just mimicking the professor. All of my labs are open and creative and sometimes my laboratories are just about experiencing."

"The women, they’re a lot more open to working on projects collaboratively. I do try to be somewhat aware of my classroom demographics. For instance, I’ve got a class this quarter that’s all male so we’ve been able to do lots of car things and guy things but if I had women in the class I’d kind of shy away from those assignment. I’d try to find things that were a little more balanced that would appeal across the group."
Additionally, relevant learning extends beyond recruitment efforts, advising, and classroom activities and surfaces in the selections of speakers and presentations as well.

“That is what we need to work on is highlighting how engineers help people. I think that is really important. To be able to profile more people who are working on things that actually the general public could understand, I think that would help a lot. Everyone always says that we don’t have a show like Seattle Engineer whereas you have LA Law or ER. You have all those shows about law, forensic medicine, police, where people can understand it. It people could take engineering as a career and make it accessible to the public, I think more people would consider it as a career.”

“When Michelle brings in speakers one of the things she’s very careful about is to make sure that we have an abundance of women engineers that come in and so the students she’s very...very um, it’s very clear that you know the students not only just the women students but men students who are majoring in engineering know that these women are there and come speak with them.”

Building Relationships

Building relationships and communities are effective ways of ensuring academic success and transfer on all levels. NW-ETEP has supported all efforts of communication among colleges and universities among peers. NW-ETEP up-holds the value of relationships between high schools and community colleges, community colleges and universities and between students, faculty members and support services in community colleges.

“I guess it kind strikes me that so much of this is about relationships at all levels, whether department chair or school of engineering chair, it’s just even that function of getting to know each other in the different cc programs and their faculty.”

“It’s been a big supporter of our human powered paper vehicle competition which is actually a result of a different NSF grant but NW-ETEP has supported and kind of built upon what started a few years ago. Now the human powered paper vehicle competition is a special two-credit class that happens once a year where the students get to make, design and build a paper vehicle that’s 90% paper and they get to go to a regional competition in Eastern Washington University and be amongst their peers from other universities and community colleges. Typically there are 15-20-25 schools in attendance and they not only compete on a track but they also have to compete in project presentation and this really builds a lot of community amongst their peers. They get to talk amongst one another so you know that’s a big thing but I think you know some of the greatest success stories are seeing our graduates go from here and get accepted to University of Illinois, University of Michigan, and University of Washington, Washington State University and to have them come back and share what they’ve done.”

Building Relationships: High school and University. Building relationships among high school students and community college students is an effective way to help high school students
understand all of the options that are available to them while pursuing a degree in Engineering. The community colleges who participate in NW-ETEP engage in many activities to increase the awareness and interest of high school students in Engineering. High school students are brought to college campuses where they are able to connect and interact with community college students. The high school students are given informational materials about Engineering and what is means to be a student in Engineering.

“One of the things we do in the engineering program is do outreach for high school students. We do a couple things. We bring a group of 30-40 students on campus and Tina and Bob really coordinate that process. We bring them on a day for some really hands on learning projects and then the other thing we do is we go out to students at college career fairs in the local school districts of four primary school districts local and we’re trying to do each of their college event nights”

“We actually have days where we set aside an entire morning about five hours or total where we’ll bring in a group of high school students and we ask the counselors at the high schools to target women and underrepresented minorities but it’s open to anyone and they assist in the selection process and typically we get groups of 30-50 people to come in the morning we provide a light very light like a bagel breakfast for them and then they embark down two paths right now one is computer science and the other is engineering and they get to do hands on activities in our labs for time periods of 30-45 minutes each and they come back, have lunch and they hear from a panel of our own engineering and computer science students and again we feel that is very powerful because we can talk all we want to people about what we’re doing but when it comes from the mouths of our students that’s been the most effective and so that’s one of the things that we’ve been doing and it seems to be very effective.”

Additionally, community college students are given the opportunity to visit high schools where they are able to tutor high school students.

“We also hire tutors to come down um from the university level and again this goes back to the students helping other students or telling other students about the programs...and so this builds upon having our community college students speak to the high school students.”

Building Relations: Community Colleges and Universities. Building relationships among community colleges and universities is also viewed as vital. While this component is viewed as necessary for the success of all of the community college students, it is viewed as a critical component for women students at community colleges. Through this connection, community college and university faculty and administrators and well as community college and university students are able to form connections and learn from one another.

Faculty, staff and support services at community colleges and universities value the relationships that exist between them. The open-door communication that is present allows for changes and adjustments within the curriculum and additional processes to be attended to in a timely fashion.
“Our project relies heavily on our relationships with our cc’s and not all STEP projects obviously are specific relationships for projects that involved cc’s.”

“One is certainly building communities at those cc’s. While there may be multicultural services at cc’s that do a wonderful job of supporting students across disciplines and across interest areas; what we wanted to do was sort of focus, the community on students that are interested in engineering and really look at what are the resources; what are the support; what sort of support they need specifically in engineering to help with their persistence in those pre-engineering courses at their cc.”

“The big thing for the community colleges here is to keep that open door pathway the two-way communication between the community college and the university and it’s huge, it’s good here in Washington, we have a very, very healthy relationship with not only the other community colleges but the university and there’s tools available. Each of the universities have planning sheets that show their course and what the equivalent course would be at the community college level so planning is a breeze. This is available on the web too. The other thing is that there are; in each of the universities too the staff is highly accessible to the community college people so they’re only just a phone call away.”

“A lot of time we have one on one advisors from WSU or from UW or four-year school and special for UW the minority fair comes here and talks to the students focusing on minority. The woman on the programs and special give them some help with how to transfer and gives them guidelines how to transfer okay.”

“For me I think we have to work closely with the university and see any change at the university we have to pass on to students. That will help the students to understand the process. Sometimes you have an advisor’s name at the university to give the students to give them more confidence. They go visit them and like UW they have Thursday advising for transfer students. We encourage them to go to the Thursday advising just for transfer student only. They don’t have to make appointment. They just show up so that has helped them to transition. They bring their transcript and work closely with the university and get passed on what you learn from the university.”

“WCERTE, the Washington Counsel for Engineering and Related Technology Education is a group of community college faculty and university faculty who convene two times a year just to talk about the academic programs and transfer issues and this has allowed us to develop seamless articulations agreement with the universities in the state of Washington so a student can come to the community college go through our coursework and know that it’s going to transfer up to the university without any problems this also allows us to develop really strong relationships with the faculty, the advising team and the staff at the university level so we see each other um, on a regular basis at the meetings and outside of these meetings, we have very strong articulation agreements and again it’s just like with our students it’s about relationships so um, we invite the university staff down here.”
The importance of relationships between community colleges and universities also exists between the students. University students are hired as tutors at community colleges and are also asked to speak to community college students about what it means to major in engineering.

“We hire tutors to come down from the university level and again this goes back to the students helping other students or telling other students about the programs. We bring university students down to tutor our engineering classes here. Not only do they get tutoring but they get a little camaraderie they can hear first hand from a university student and preferably one that’s transferred from our institution exactly what its like.”

“We also bring in some women students who are majoring at the University of Washington in engineering so we’ve also brought them in to talk to the students that were probably one of our more successful events.”

**Building Relationships: University Faculty, Administers, Support Services and University Students.** The participants of NW-ETEP also value the relationships that exist among students and faculty and administrators at the community colleges. Understanding the interest of their students and knowing that the students understand that the faculty and administration values their learning is important.

“When students come in to the institution when they first show up here we really start to build a relationship with the student and that’s I think one of the key things that happens here.”

“NW-ETEP there’s we’ve been really focused on our engineering 100 class and in terms of in the classroom types of things I think this is where NW-ETEP has had a great impact so far and the engineering 100 class is simply a one credit class that meets once a week and again this is where we’ve really started to strengthen relationships with the students the first thing we do is connect with our educational planning center, have the students make a connection with the engineering department or the science departments and actually put the students in touch with a faculty advisor or myself to do some kind of focused advising.”

“I wanted to hold all the students and have them know that people were there for them. I wanted full time people to teach it [Engineering] so I found all of these people who have degrees in engineering who teach other things like math and computer science and one of our instructors actually who is our institutional researcher.”

*We do try to build a community with our students and we try to know who our students are. We have events for our students that everyone is a part of and then in that respect creating a community and not letting underrepresented students feel like they’re on the exterior.”

“It really is the connection and so it’s fairly selfish with me. I want to connect with my students. It really is the connection with them. What are you thinking about this and why are you thinking this way and it takes a long time to develop that.”
Additionally, the connections and relationships that exist among the students, faculty and administrators ensure that the students view faculty members and administrators as accessible. The resources that are provided to the students exemplify their commitment to students’ successes.

“I think that in our science and engineering departments here the faculty and the advisors really, really emphasize building relationships with students so they feel that we’re accessible and that they can come to us with problems.”

“The math faculty here have the commitment to student success in mathematics. The other thing that it allows the math faculty to do is highlight some resources which are available for student success in mathematics. For instance this year will be the second year we started a math resource center in conjunction with our tutoring center and that’s a good opportunity for them to say hey these resources exist”

“In the cc’s we build success around accessibility to faculty whereas if you went to school in a different part of the world there’s a real divide between access to faculty and student success. There’s a separation. The faculty are not accessible. A lot of our international students or immigrant students will have to learn that we expect them to be able to approach faculty for success. We really try to blend those lines. That’s a learning opportunity for our students that they realize they can go sit down and have a conversation.”

**Student Engagement**

Actively engaging students is another theme that emerged in this study. Many opportunities for students to connect and immerse in different activities are made available by the faculty and staff involved in NW-ETEP. Students are provided with written assignments that allow them to reflect on their interests and goals. Students are also presented with hands on activities and field trips and conferences to further expand their knowledge of Engineering. Additionally, speed dating sessions are organized so the students can engage in conversations about academic careers as well and careers in business and industry. Students are also encouraged to form study groups in order to stay connected and engaged in academic activities.

Students are engaged through the exploration of engineering organizations that will serve as networking outlets. Students are also encouraged to reflect on their own learning and submit an assignment on how they will be successful in math classes.

“One page summary of what it means to be involved in an engineering organization. Whether you want to do IEEE, AICHE, SACE, etc. They need to at least research what options are available for students there.”

“They need to write a one page summary on how they’re going to be successful in mathematics. We devote an hour of that class to student success in math related classes and we’ll have either a student that’s gone through the progression or a large progression of the class will come in and/or a math instructor come in and talks.”
Experiential learning has been highlighted as an effective tool for encouraging active engagement. Through NW-ETEP, students are provided with different projects that allow them to really apply the skills they have learned.

“For example in statics we do a couple projects: one where students have to build mobiles and have to do the engineering calculations around the balance of the elements, the mobile, in that the sum of the forces and the sum of the moments have to be equal to zero and so that’s the first project we do. The second project we do is a photo scavenger hunt.”

“We really highlight experiential learning projects.”

“I’m able to apply those things to helping students work with their hands to create in the shop and to make things. I think that is a huge impact on our students; to touch and to build and to saw. I really try to infuse as much of that part of my education and background into what we do here because I think students really learn by doing.”

Additionally field trips to university settings where they experience open house days, conferences, Speed dating sessions and community activities.

“Yeah but the other thing that we do through NW-ETEP is we do field trips that up to the university. We’ll go to their engineering open house days, their conferences and other things in the community.”

“Michelle she organizes the field trips she makes sure that, she has the registry of students. She contacts them frequently. She sends them information. She takes them out and about. This quarter she’s brought in probably nine speakers about engineering.”

“A Speed dating session is where we line up about fifteen engineers and we have our students come in and they get to spend about three-and-a-half to four minute with each engineer. When the time’s up it’s time and they move on but they’re free to ask them anything that they want, “how did you come to be an engineer”, “what’s it like now,” “what’s the education process like” and it’s been wildly successful. We not only try to reach the students on many different levels both academically, in the classroom, with other students from the university level but also through the community, through business and industry and government so...”

Study groups are also encouraged of all students. The advisors view it as essential that all students make connections with other students and form study groups.

“I think that cohort building is really important. You can get a lot of mileage out of bringing groups of students together, encouraging them to study together to make friends and to have a social network to support each other. That takes a lot of the owness off of the support staff if you can get peer mentoring going on. I think that part is really important. It is important to have role models.”
“So all of the messages that we give the students through advising are reinforced and one of the big ones is to form study groups. We tell them [the students] as advisors, the first thing you should do in the classroom is reach out to other students and form a study group.”

Discussion

NW-ETEP has been a huge supporter in initiatives geared towards increasing the representation of women and minorities in Engineering. There were five key findings that emerged from this study: a) the faculty, administration and support staff believe that it is important for students to **Pursue the right path**. There are many reasons that students attend community colleges. Some attend with the intent to transfer while other students are seeking a vocational degree; b) **Effective Collaboration** is another theme that emerged among the NW-ETEP Participants. Effective collaboration keeps community colleges and faculty members abreast on changes that are occurring within the academic environment; c) **Relevant Learning** in this context implies that learning is geared toward the needs and interests of the students. This concept is essential to the academic success of all students, more specifically underrepresented populations such as women and students of color; d) **Building Relationships** on all levels ensures that high schools, community colleges, and universities are able to successfully communicate and respond to student trends, issues and challenges that may arise. This type of relationship also ensures that resources are available on all levels and makes certain that interested students are able to make smooth transitions and e) **Student Engagement** and positive interactions are important. Experiential learning is an effective way for students to apply their learning. The findings of this study offer a number of implications.

Implications for Research, Policy and Practice

Community colleges are in a unique position to increase the number of people in the scientific talent pool and to diversity for its ethnic and gender composition. Doing so will require a serious commitment to recruiting talented students, encouraging them to pursue science and math careers, providing necessary facilities and academic services, and ensuring a smooth transition from the two-year to four-year college. STEP programs such as, NW-ETEP, which consists of partnerships with high schools, community colleges and other universities. (ERIC Digest, 1991)

The findings suggest that placing students on the right path early in their academic career and providing them with information and resources that are applicable to their interest and goals is viewed by faculty and staff as an important component of a student’s academic career plan. The students recognize this proactive notion and become equally engaged in the classroom and in extracurricular activities and organizations. The findings also suggest that the collaborations among the faculty and staff internally as well as externally among high schools and universities have proven to aid in student success in STEM areas.

The findings of the analysis have particularly important implications for policy and practice in that understanding the impact of faculty and staff on students and the perceptions of community college faculty and staff on their role in increasing the participation of women in STEM majors
adds to the literature on transfer student success. Additionally, this information provides a framework consistent with the research on faculty and student engagement. A clear understanding of the roles among faculty and staff as well as indicators of student success influences the initiatives designed to increase this underrepresented population.

References


